ANATOMICAL AND PHYSIOLOGICAL COMMENTARIES.

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ANATOMICAL AND PHYSIOLOGICAL COMMENTARIES.

Introductory Observations on a Vital Principle.

So much importance has been recently attached to inquiries respecting a Principle of Life, and the opinions maintained by different individuals have been so much at variance, that an impartial consideration of this subject may form no unfitting introduction to a series of Physiological Essays. In the following remarks upon a Vital Principle, I make indeed little pretension to novelty, as the reflections of several of my friends have led them to adopt conclusions similar to my own; but I am inclined, on this account, to hope that what I advance will bear the test of candid examination.

In every example of rigorous philosophizing, the terms Principle, Law, Property, are used indifferently,

and are intended to express some general fact: thus it is equally correct to speak of the law, or the principle, or the property of gravitation; by each of which expressions one and the same general fact is alone implied, viz. that all bodies are attracted towards each other in the ratio of their masses, and with forces increasing, as the squares of their distances decrease. Such Laws, Principles, or Properties, are ascertained by a cautious induction of particular instances, whereby it is rendered evident, that the fact holds good under every conceivable variety of circumstances. Philosophical principles, which have been thus established, are in their nature incontrovertible, though they remain liable to be merged in expressions still more general. I know of no general fact in Physiology better calculated to illustrate the preceding observations, than that law of vision, which relates to our seeing such objects erect, as under ordinary circumstances are painted upon the retina reversed.

It may be remarked, as a corollary to the preceding statement, that, when all the phenomena of any science shall be contained under one expression, or in other words, when there shall be discovered in any science a law or principle, from which all its facts shall be synthetically deducible, that particular science will admit of no further improvement by the human intellect.

But the term Principle is sometimes employed with a looser meaning, in cases where rigorous laws have not been ascertained; thus, it is not uncommon to speak of a principle of electricity, or of magnetism: in

these and similar instances, the term seems merely to denote what is conjectured to be the common circumstance, characterizing the phenomena, to which it relates, and marks the want of those well-defined laws, of which it is the temporary substitute.

I believe that no other meaning can be attached to the word principle, whenever employed in relation to the facts of natural philosophy, than one of the two above explained: if I am right in this supposition, there will be no difficulty in deciding, in which of these two meanings the word is used in the expression, a vital principle. No one, I suspect, will venture to admit that all the phenomena of life are accurately understood; yet without this previous admission, they cannot be referred to a principle or law of the first kind, which I described. It is well known, indeed, that of the vital phenomena, which are best understood, there exist several classes, so thoroughly distinct in kind, as to render it extremely improbable, that a single law will ever be discovered comprehending the whole. If, again, it be granted, that in the instance before us, the word is used in its looser meaning, nothing, I conceive, is wanting to prove the trivial nature of all discussions respecting the existence of "a Principle of Life."

It will probably occur to the reader, in confirmation of what I have advanced, that the advocates of a vital principle have their strongest ground in those cases, the phenomena of which are more than usually ob-

scure; as when they detail the vital phenomena of the seed or egg, before the developement of the plant or animal begins: the truth, in this instance, is simply this; we are too slightly acquainted with the phenomena in question, to be able to reduce them to general laws.

But in the economy of grown plants and animals we certainly have obtained glimpses of those properties or principles, which are the legitimate objects of philosophical inquiry. It is indeed mortifying to confess, that in no one important instance is our knowledge of a vital law complete, and that it is even possible, that a more successful research may show, that all our present conclusions are erroneous; still it is interesting to trace any thing like an approximation to inductive principles in Physiology.

The law the most remarked, if not the most extensively prevalent, in living bodies, is, that certain textures, which are generally fibrous, when existing within a certain range of temperature, and under other conditions more or less accurately defined, will, if excited by certain agents, or as the mere result of their structure, suddenly contract themselves in one dimension, if not mechanically prevented, and that the preceding change naturally alternates with the relaxed state of the texture. To this principle, as it is found in the muscular fibre of living animals, Haller gave the name of Irritability; and the same term may be applied, till some reason be shown to the contrary, to

similar phenomena occurring in other textures, whether animal or vegetable.

A second property is that, by which solids and fluids are decomposed in living bodies: this process is unquestionably analogous to chemical conversion; but it seems trifling to give the general fact a name, whether organic affinity or any other, till the conditions, under which it occurs, be more exactly defined.

Sensibility and the other mental properties are satisfactorily traced in those animals only, which possess nervous systems; with certain conditions of these organs the mental properties seem closely connected; but on this head very little is known with certainty.

This slight notice of what seem to constitute our nearest approaches to philosophical laws of life, will serve to illustrate the yet backward state of Physiology, and at the same time to point out definite and legitimate subjects of inquiry. Bichat indeed was the first, who saw distinctly, that Physiology admitted of rigorous principles, yet he failed in his attempt to elucidate them. As I am not aware that any individual has pointed out the errors of Bichat's system of vital properties, I will state some objections to it, which have doubtless occurred to many.

"Nature," says Bichat, "has endowed each part of a plant with the faculty of being sensible to the impression of those fluids, with which its fibres are in contact, and with the power of reacting insensibly upon them, so as to promote their transmission. I call these two faculties, the one, the organic sensi-

bility, the other, the insensible organic contractility *."
The reader infers from the next sentence, that the same properties prevail as universally in animals.

By this account, the organic sensibility is that property, in virtue of which the irritable fibre is excited by certain impressions in preference to others; but it is evident, on a moment's reflection, that the susceptibility to particular impressions is an essential element of the property of irritability, or, as Bichat terms it, contractility. If the existence of such a separate property were admissible in this case, by parity of reasoning, an organic sensibility should be attributed to matter in general; in virtue of which bodies would gravitate towards each other in the ratio of their masses, rather than in the ratio of any other quality.

Under the title again of insensible organic contractility, Bichat has thrown together properties so dissimilar, as that, on which the propulsion of a fluid through a tube depends, and that, by which its conversion into a new substance is effected: sometimes,

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* "La nature doua chaque portion de végétal de la faculté de sentir l'impression des fluides, avec lesquels les fibres sont en contact, et de réagir sur eux d'une manière insensible, pour en favoriser le cours. J'appelle ces deux facultés, l'une *sensibilité organique*, l'autre *contractilité organique insensible*."—Anatomie Générale, par Xav. Bichat, Tom. I. p. 12.

indeed, he seems wholly to lose sight of the existence of the latter property. After noticing such grave errors, it is scarcely worth while to point out the want of keeping displayed in his outline of the vital properties, on the occasion, when he enumerates as distinct principles three modifications of irritability, and clubs all the mental properties under the single term, animal sensibility. The striking boldness and general felicity of Bichat's speculations render it as expedient, that his errors should be pointed out, as they ensure the admission of his numerous correcter views.

In some of the preceding observations I have touched a chord, which has jarred somewhat in abler hands; I allude to the support, which the theory of materialism is supposed to derive from expressions similar to some made use of above. I have spoken of sensibility and the other mental properties being as seemingly connected with a nervous system, as irritability with a fibrous organ. I certainly am inclined to believe, though the evidence is in part analogical only, that no change whatever takes place in the functions of the mind, but in conjunction with a corresponding change in some part or the whole of the nervous system; and so far, physiologically speaking, the connexion between the mental properties and a peculiarly organized matter seems as strict, or nearly so, as that between irritability and another kind of matter. But the value of this argument in reference to materialism, I take to

be neutralised by the consideration, that mind and matter are logically distinct substances, and that there is nothing in their constant conjunction in our present condition, which renders their separate existence morally impossible, or interferes in the least with any probable evidence to that effect derived from other sources.

It would require more profound study, than I have given the subject, to enable me to entertain a positive opinion on another question, always drawn in on these occasions, whether, either the denial of a vital principle, or a physiological materialism, be inconsistent with revealed religion: but I confess to a plain straight forward thinker it would seem clear enough, that the several vital principles, which the inductive philosophy bids fair to establish, are as consistent with the tenor of the sacred writings, as the single vital principle of less precise signification; and with respect to a physiological materialism, not to mention the uncertainty of the argument, compared with the singular abstruseness and obscurity of the subject, I cannot help thinking, that even wer[illegible] theory of materialism established, and I am far from thinking it to be so, it would not clash with the doctrines of revelation, which treat this point ambiguously, and in several places seem directly to favour the idea of an eternal connexion of the mental principle with a modified corporeal one.

It is much to be deprecated, that in this enlightened

age the discoveries of philosophy should be employed on the one hand unfairly in undermining religion, and on the other hand, through an equal ignorance of their real bearings, be rejected as hostile to its interests.

Experiments illustrating the Phenomena of Muscular Action.

Muscular flesh, viewed as an object of physiological inquiry, is far from being a simple substance; but consists of blood-vessels, absorbents, and nerves, probably blended with some peculiar element, which appears to be inseparable from the other component parts of muscle.

Living muscle is observed to exist in two states; in one of which it is soft, and yields readily to pressure and extension; in the other it is hard, is with difficulty extended in the direction of its fibres, and, if no mechanical resistance interfere, it becomes shorter in this dimension. The former condition of a muscle is termed its state of relaxation; the latter, its state of action; it has been ascertained by Dr. Wilson Philip*, that some muscle will exhibit an alternation of these phenomena for as long a continuance, after its connexion with the brain and spinal marrow, by means of the nerves, has been interrupted, as when this connexion exists; whence it is inferred, that the irritability of muscle is not derived from either of the sources named.

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* Philosophical Transactions, Vol. CV. p. 81.

Previously to inquiry, we might conjecture either the state of action, or the state of relaxation (the terms no doubt being in this view objectionable), to be that, to which a muscle would revert in the absence of special impressions, or, in other words, to be that condition, which is the natural result of its structure; or we might suppose, with equal probability, a succession of these states to flow necessarily from the composition of a muscle: upon this general question I am afraid the following experiments throw little additional light, even if their details have any separate interest.

When a muscle of voluntary motion is exposed in a living body, and the joint, of which it is the flexor, be moderately bent, its fibres appear to lie in a right line: if the muscle be then excited to action, the brief contraction, which ensues, is unattended with any change in the direction of the fibres of the muscle: if the joint be bent to the utmost, the fibres of the muscle appear thrown into slight folds; and if the muscle is then excited, this appearance of folds is not lost. When a muscle is examined in its utmost degree of extension, or in its middle state, upon the limb of an animal very recently killed, the fibres appear straight; if the muscle be then divided, its portions retract, and its fibres describe waving lines. These experiments I have repeated several times on rabbits.

The general lateral swelling of a muscle during its action is as obvious as its hardening; and it is in the highest degree probable, that each fibre increases proportionately in breadth; but of this I cannot satisfy

myself by observation, without or with the microscope.

Various experiments have been made to determine, whether a muscle gain or lose in bulk during its contraction; all that I have met with have been exceptionable, on one ground or another; as, for instance, on the ground, that fluid might be retained in or leave the muscle or the limb at the moment the former contracts; or again, that there might co-exist some counteracting relaxation of an antagonist muscle: the objections, which I have mentioned, do not seem to me to apply to the following experiment.

A glass vessel was procured, having a narrow and open tube, three-tenths of an inch in diameter, at its upper part, and a large glass stopper removeable from its under surface; into this vessel, when inverted, and filled with coloured water, the ventricular part of the heart of a large dog was introduced, immediately after its excision from the animal, which had been previously destroyed by hanging; the vessel was then raised, with its tubular part uppermost, and the heart continued to contract vigorously for a sufficient length of time to enable me to be assured, that no elevation whatever or depression of the coloured fluid took place in the tube during the action of the heart. I have repeated this experiment several times. If it be true, as it is supposed, that the whole of the ventricular portion of the heart contracts at the same moment, any expulsion of fluid from the coronary vessels, during the action of the muscle, would not in

this instance interfere with the conclusion, which seems to me unavoidable, that the bulk of living muscular fibre remains the same in its different states.

With a view to ascertain whether the presence of blood in the vessels of a muscle be necessary for its action, the following experiments were made: The heart, together with a portion of the aorta, was removed out of the chest of a dog, immediately after its destruction by hanging; the tube of an injecting syringe was then fastened in the aorta, and warm water thrown into the coronary vessels, the heart still beating actively: while water was thus thrown in, in sufficient quantity to entirely wash the blood out of the heart, which became thickened, and had the appearance as of having been macerated for a few days, the contractions of the organ continued vigorous; but they ceased much sooner, after the injection was desisted from, than would have been the case, had this experiment not been made: on repeating the experiment, a similar result ensued; on a third trial, being willing to try to what extent the introduction of warm water could be carried, I injected considerably more than was sufficient to render the heart of a pale colour; the heart in this case swelled considerably, and after one or two beats became at once rigid, as if crimped. A similar experiment was made upon the voluntary muscles of the lower extremities of two dogs, with a like result; the tube being placed in the femoral artery, the muscles of each limb so treated became swollen and œdematous and pale, yet did not at first lose their

irritability, though they soon became hardened, as the heart became in the preceding case. It may be inferred from these details, that the presence of blood in the vessels of a muscle is not necessary to its action, but probably conduces only to the nutrition of the part, and the preservation of its temperature.

It seems probable that the habitual degree of contraction, which is remarked in certain muscles, and has been termed their tone, results from an act of volition: when all the branches of nerves passing to the lips of an ass are divided on either side of its face, the lips are observed to hang flaccid, disclosing the teeth of the animal: in a similar way, when in human beings one side of the face is paralysed, its expression is lost, the features of that side being partly drawn towards the opposite side, and partly dropping from the mere weight of the integuments. In order to ascertain, whether the muscles of voluntary motion have a tendency to assume any definite dimension, independently of the influence of the will, I exposed in the hind leg of a rabbit recently killed, those muscles which correspond with the tibialis anticus, and the extensors of the toes in human beings, and having fixed a piece of fine wire in two neighbouring tendons at the same level, as a measure, I divided one tendon when its muscle was extended to the utmost, and the other when its muscle was perfectly relaxed. I have repeated this experiment on the same muscles and on others, and on the portions of a single muscle, longitudinally separated; and in the majority of cases, the muscle, the tendon of which

is divided when on the stretch, is the most shortened of the two, and remains so. In a few instances I found no difference in the subsequent length of the muscles attend their division, made under these different circumstances. It may be mentioned, in connexion with the preceding facts, that the voluntary muscles become rigid at a certain period after death, without any reference to the position of the various joints of the body.

The spontaneous elongation of a muscle in some instances attends its relaxation, as in the heart removed from the body of an animal recently killed: a similar circumstance may be noticed in the voluntary muscles at the same period. When these are exposed a few minutes after death, rapid contractions soon begin to play over them: these appear to commence some short time after the exposure of the muscle. If when these are present the muscle be divided, after the first sudden retraction of either portion, the brief contractions continue as before; subsequently to each of which the portion of muscle distinctly and fully regains its previous length.

From several of the preceding observations, viewed in connexion with others more generally known, I should infer that the relaxed state is that, which is natural to the voluntary muscles, and that their contraction results from a casual extraneous impression; an inference, I believe, in nowise at variance with that generally received. But I am inclined to adopt a different conclusion relatively to the heart, and to

suppose that the alternation of action and relaxation in this muscular viscus results immediately from its structure. This at any rate I take to be the just conclusion deducible from the facts at present before us, and that which would be logically secure, were we certain that no additional facts bearing upon this point would be brought to light.

The facts, to which I allude, are the following: when the heart of one of those animals, which are the usual subject of physiological experiment, is removed from the carcase immediately after death, it seems to contract and dilate for a little time with full vigour; whence we may infer that neither the brain nor spinal chord furnish the stimulus to each contraction, as occurs in the voluntary muscles. The true explanation may now be perceived of the beating against the side of the chest, which is synchronous with the diastole of the aorta: the heart contracting upon the table, is observed to throw up its apex at each systole of the ventricles; the superior weight of the base of the heart in this case gives the part that fixedness, which in the body it derives from the vessels, which are continuous with it. When the inner surface of the heart is washed out carefully, the motion of the heart continues unimpaired; nor, as I have before mentioned, does even the washing out the blood contained in the coronary vessels immediately affect the action of the heart.

When the auricles again are cut off, the alternate contractions persist: if the auricles be cut off with a

small portion of the ventricles, so as that they preserve their natural form and expansion, they may be seen contracting fairly and equably as before, keeping exact time with the separated apex of the heart; and when, as is usually the case, the contraction of the ventricles declines before that of the auricles, I have noticed the separated ventricles still keeping time with the auricle, and at first accurately intermitting the beat, which should follow each second contraction of the auricles: the latter circumstances may have been casual.

Finally, if such a longitudinal section be made, as to divide the septum and either auricle and ventricle of the heart, the separate portions continue to act regularly for a short space of time.

Essays of Reil on the Structure of the Cerebellum.

The observations of Reil on the structure of the brain, as shown after its induration in alkohol, are nearly unknown in this country. As they possess the highest interest in every point of view, I shall venture to offer the whole of them to the public in an English translation, together with accurate copies of the engravings which accompany the original essays. With the assistance of these engravings the reader may easily repeat, as I have done, the dissections, which Reil describes.

At present I publish the matter of four essays only, which treat of the cerebellum. These are to be found in the 8th and 9th volumes of the Archiven für die Physiologie of Reil and Autenrieth, which correspond with the years 1807 and 1808 *.

In translating these Essays, I have taken the liberty of occasionally condensing the descriptive details given by the celebrated author, where, by so doing, I might diminish their intricacy and obscurity, as well as that of wholly omitting passages consisting of reflections of no physiological value.

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* It appears, upon his own statement, that Reil commenced this series of inquiries about the year 1795.

Inquiries respecting the Structure of the human Cerebellum, by Professor Reil. Archiven für die Physiologie, achter band. p. 1—58.

I.

Description of the external surface of the Cerebellum.

THE cerebellum is not composed of elementary portions essentially different, but is one homogeneous organ; externally it consists of laminæ of medullary matter [mark blätten], which are enveloped in cortical substance [rinde], and are attached to medullary-stems [markstämme]. The medullary stems, on the one hand, branch into lobes [läppen] and lobules [läppchen], the subdivision ending with the laminæ; on the other, they unite to form central medullary nuclei [markkerne]. From the latter three processes are given off on either side, comprising two to the cerebrum, the pillars of the Vieussenian valve, two to the medulla oblongata, the corpora restiformia, and a third pair situated between the two former, passing to the annular protuberance.

The cerebellum lies below the posterior lobe of the cerebrum, in a cavity, which is enclosed below and behind by the sphænoid and occipital bones, laterally by the petrous portions of either temporal bone, and

above by a process of the dura mater. The cerebellum measures transversely, at its greatest breadth, from three inches and ten lines, to four inches; longitudinally, above, and in the centre, twenty lines: either lateral portion is about two inches long, and about sixteen lines thick at its middle. The lateral parts are called hemispheres [seitentheile, hämisphärien]. The central part is called the general commissure [mittelstück, nath, total-commissur, wurm], and consists of two portions, the superior and inferior vermiform processes. The superior of these terminates at the commissure of the upper and posterior lobes. When viewed from above, the two hemispheres are externally circular; internally, where they approach to join the general commissure, their margin is deeply notched both before and behind. Thus two fissures [ausschnitte] are formed, one looking forwards towards the cerebrum, and receiving the tubercula quadrigemina, termed the semilunar fissure [vordere, halbmondförmige ausschnitt]; the other backwards, which receives the falx cerebelli, termed the purse-like fissure [hintere, beutelförmige ausschnitt], from its narrowness at first, and subsequent enlargement: in the latter is the line, at which the superior and inferior vermiform processes meet.

The upper surface of the cerebellum is not horizontal, but raised a little anteriorly towards the tubercula quadrigemina, and depressed laterally and behind. The under surface is somewhat hemispherical, having along its middle a deep and broad depression, the

valley [thal], extending from before backward, in which the medulla oblongata is lodged, as well as the inferior vermiform process: the latter is separated from the hemispheres on either side by a furrow. The valley is broadest at its middle, where the pyramid is placed: behind this point it is contracted by the inner extremities of the lower and posterior lobes, and before by the almond-like lobes.

I employ the term horizontal or lateral fissures [seitliche horizontal-furche], to designate those depressions, which extend transversely across the fore part of the cerebellum, and contain the processes passing to the annular protuberance. These fissures are continuous with the intervals between the upper and under posterior lobes, which extend as far as the purse-like fissure: thus a deep furrow may be traced all round each hemisphere, dividing the cerebellum into an upper and an under portion.

Either surface of the cerebellum is composed of that laminated structure, in which the medullary processes rising directly from the nuclei ultimately terminate: the laminæ are divided by furrows of greater or less depth, which are more or less parallel to each other, and constitute each a segment of a circle, the convexity of which is turned backwards, and the horns forward and towards the horizontal fissure. The deeper furrows pass down to the medullary nuclei, and form the boundaries of lobes: the shallower furrows, which are not continued over the entire surface of a hemisphere, form the boundaries of lobules. This structure is best

understood from the vertical section of an hemisphere.

In some places, particularly in the deep furrows between the lobes, and in the shallower furrows of the lower and posterior lobe, several laminæ are sometimes found united, so as to form an irregular band of short extent [ein schwanz]; sometimes an abrupt and tongue-like projection [eine zunge] arises from the bottom of a furrow, consisting of a few laminæ, not directly connected with any neighbouring lobe or lobule.

Each hemisphere has five lobes, of which two compose the upper, three the under surface: these are, first, the square, or anterior and upper lobe [vierseitigen, vörderen oberen lappen], which is seen on either side of the superior vermiform process, forming the fore part of the upper surface of the cerebellum. This lobe extends from the tubercula quadrigemina to the commissure of the upper and posterior lobe, and is united to the vertical process of the general commissure, and to all those portions of the horizontal process, which are given off above the single commissure. Secondly, the posterior and upper lobe [hinteren oberen lappen]; which forms the upper and posterior surface of the cerebellum, extending as far as its margin. The limits of this lobe are easily defined by tracing its union with its fellow, by means of the single commissure, and following from thence the furrow, which is continued outwards to the horizontal fissure betwixt this lobe and the next. Thirdly, the

lower and posterior lobe [hinteren unteren Lappen]; this is united to its fellow by the short and exposed commissure, and by the long and hidden commissure; and sometimes it adheres to the posterior surface of the pyramid. The fourth, or slender lobe [zarten Lappen], is joined to its fellow, sometimes by the last laminæ of the long and hidden commissure, but for the most part by the laminæ of the posterior part of the pyramid. The fifth, or biventral lobe [zweibaüchigen lappen] lies between the slender lobe and the almond-like lobe. The latter is pressed inwards towards the valley, while the biventral lobe is the last, which conforms to the circular arrangement of the parts upon the under surface of the cerebellum. This is distinguishable by its wedge-like form, by the direction of its furrows, which are nearly parallel with the medulla oblongata, and by its union with its fellow, through the anterior laminæ of the pyramid, in the valley.

If we examine the contents of the valley, beginning at the upper part of the purse-like fissure, we find that they occur in the following order: above is placed the single commissure [einfache quer commissur], by which the upper and posterior lobes of either hemisphere are connected; immediately below this the short and exposed commissure [kurzen und sichtbaren commissur], by which the under and posterior lobes are united; below this again the long and hidden commissure [langen verdeckten commissur], by which the under and posterior, as well as the slender lobes

in a basin under water, and the membranes removed with the forceps: the membranes are prevented from drying, and the blood exudes more freely, when the part is thus immersed in water. The denuded cerebellum is now to be placed in a vessel, and to be twice washed by the affusion of brandy, which may be suffered to remain on it some minutes; afterwards alkohol is to be substituted, in which it should stand twelve hours; when in this way, the surface appears somewhat hardened, the membrane is to be removed from the deeper furrows, in order that the spirit may every where penetrate the mass; spirit is then again to be poured over the preparation, which may stand a day or two: finally, the alkohol is to be renewed, and the vessel closed and set by for two or three months, till the part has acquired a greyish colour, and is thoroughly hardened. It is right, during this time, to turn the preparation occasionally, and to contrive that every surface is freely bathed in the spirit.

Explanation of the First Plate.

Fig. I.

This figure represents the upper surface of the Cerebellum.

a. a. The Crura Cerebri divided near the annular protuberance.

b. The Pineal Gland.

c. c. The transverse bands of medullary matter lying below the Pineal Gland.

d. The Tubercula Quadrigemina.

e. e. The fourth pair of Nerves.

e. h. e. The Anterior or Semilunar Fissure of the Cerebellum, enclosing the peduncles of the annular protuberance and the tubercula quadrigemina; the margin of the fissure is parallel to the course of the fourth pair of nerves, which bodies it additionally contains.

f. f. The Superior Vermiform Process of the Cerebellum, by means of which the square lobes are united. This part is distinguished from the hemispheres by a shallow furrow on either side, and by the incurvation of its laminæ forwards, whereas those of the square lobe are inclined in a contrary direction.

m. l. i. e.—m. l. i. e. The two Hemispheres which are united centrally by the general commissure.

g. g. The Anterior or Square Lobes of the Cerebellum, which are separated into lobules by shallow furrows.

h. The Central Lobe in the semilunar fissure.

i. i. The deep furrow which separates the square lobe on either side from the upper and posterior lobe, and runs outwards to join the horizontal fissure, while posteriorly it terminates in the purse-like fissure.

k. k. The Upper and Posterior Lobe.

l. l. l. l. The deep furrow by which the upper and posterior is separated from the lower and posterior lobe.

m. m. The inner extremities of the under and

posterior lobes, which contract the entrance of the purse-like fissure.

i. i. l. l. The Posterior or Purse-like Fissure.

Fig. II.

The Cerebellum, as seen from before; the annular protuberance, its peduncles, and the lateral parts of the upper and lower lobes, which reach the horizontal fissure, are seen.

a. a. The Crura Cerebri divided.

b. The deep hollow between these and the anterior margin of the annular protuberance, out of which the third pair of nerves emerges.

c. The Annular Protuberance.

d. The Medulla Oblongata divided.

e. e. The fifth pair of Nerves.

f. f. The Peduncles of the Annular Protuberance lying in the horizontal fissure.

e. f. k. g.—e. f. k. g. The Horizontal Fissure on either side, which contains the peduncles of the annular protuberance, the latter being overlapped by the outer extremities of the lobes. This fissure is continuous with that deep furrow, by which the two posterior lobes, and thus the upper and under surfaces of the Cerebellum, are separated from each other.

h. i. f.—h. i. f. The terminations of the square lobes in the horizontal fissures.

h. g. k.—h. g. k. The terminations of the upper and posterior lobes in the same fissure.

k. g. l.—*k. g. l.* The Extremities of the lower and posterior lobes lying over against the former.

l. m. n.—*l. m. n.* The Lobules of the biventral Lobes, which are in contact with the flocks, and in the horizontal fissure lie overagainst the square lobes.

n. n. The flocks on either side, the globular ends of which project in the interval between the fifth pair of nerves, the lobules of the biventral lobe, and the square lobe.

The Second Plate.

Fig. I.

In this figure the under surface of the Cerebellum is represented: the annular protuberance, its peduncles prolonged into the horizontal fissures, the inferior surface of the hemispheres, and the inferior vermiform process in the valley, the component parts of the latter being somewhat separated, are seen.

a. a. The Crura Cerebri divided.

b. b. The third pair of Nerves, fasciculated at its origin, which springs out of the funnel-like hole.

c. The Annular Protuberance.

d. d. The Peduncles of the Annular Protuberance, which lie between the two surfaces of the Cerebellum in each horizontal fissure, pass forward above the flocks, and unite to form the annular protuberance.

e. e. The fifth pair of Nerves, in their structure fasciculated.

f. f. The sixth pair of Nerves, also fasciculated.

g. g. The Portio Dura of the seventh pair, on either side; which emerges from a hollow, enclosed before by the annular protuberance, internally by the corpus olivare, and externally by the peduncles of the medulla oblongata.

h. h. The Portio Mollis of the seventh pair, on either side.

i. The Medulla Oblongata divided; at the fore and under part of this body is a triangular hole, bounded before by the posterior margin of the Annular Protuberance, and laterally and behind by the pyramidal bodies; into this hole a branch of the basilar artery plunges.

k. k. The outer and projecting extremity of the lobules of the Square Lobe on either side: these are opposed to the outer extremities of the inferior lobes of the Cerebellum, which form the under margin of the horizontal fissure.

l. l. The Flocks; their white stems rising from the almond-like lobes, and their grey, foliated, and globular ends are seen. A few laminated processes are attached to each stem, particularly at its posterior margin, which overlap the peduncles of the annular protuberance.

m. m. The upper side of the Fourth Ventricle.

n. The Nodule.

o. The Spigot.

p. The Pyramid.

q. The Short and Exposed Commissure in the posterior fissure.

r. The Posterior or Purse-like Fissure.

s. s. The Almond-like Lobes.

t. t. The Biventral Lobes, which extend wedge-like towards the Valley (as is best seen on the left side), and are united by their apices to the Pyramid.

u. u. The Slender Lobes.

v. v. The Under and Posterior Lobes.

Fig. II.

The Cerebellum viewed from behind.

a. a. The Posterior Margin of the Annular Protuberance.

b. The Medulla Oblongata divided transversely.

c. c. The Almond-like Lobes.

d. The Pyramid.

e. The Short and Exposed Commissure in the posterior fissure.

f. The Single Commissure of the upper and posterior lobes. It resembles in structure the short commissure, and might be accounted the first transverse lamina of the latter: it is placed intermediately between the two vermiform processes *.

* Reil appears at one time to class the single commissure with the parts of the inferior vermiform process, at

g. The posterior part of the Superior Vermiform Process, extending to the single commissure.

h. h. The Apex of the Biventral Lobe.

i. i. The Slender Lobes.

k. k. The Under and Posterior Lobes.

l. l. The Upper and Posterior Lobes.

m. m. The inner extremities of the posterior lobules of the Square Lobe, which are continuous with the superior vermiform process.

II.

Of the Vermiform Processes, or General Commissure, by which the two Hemispheres of the Cerebellum are united.

UNDER this title I include all those parts, which are divided by a vertical section carried through the median plane of the Cerebellum; viz. at the upper and fore part, the anterior medullary velum, the superior vermiform process ending at the single commissure, the short and exposed commissure, the long and concealed commissure, the pyramid, the spigot, and the nodule, which occur in the above succession.

The following sketch may serve to give a general

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another, to consider it a body separate from and intermediate between either vermiform process.

idea of the double arrangement of parts, which is met with in the structure of the cerebellum: externally there would seem to be an apparatus, partly composed of vessels and cortical substance, in part again of the medullary matter immediately subjacent, which may be followed in its curvilinear course to the annular protuberance: this apparatus may be compared to the plates of a voltaic pile; the cortical and medullary laminæ, which compose it, are merely in apposition, and may easily be drawn asunder, leaving smooth surfaces. Internally, there would seem to be an apparatus, more or less analogous to the conductors of a voltaic pile; this internal part is continuous above with the tubercula quadrigemina, by means of the peduncles, which pass to these eminences; and below with the medulla oblongata, by the peduncles frequently termed corpora restiformia.

This general plan seems to be followed on all occasions; in the cerebellum of the bird, it is adopted in its simplest form: in this instance there is one erect pyramidal process, with double laminæ before and behind, in the medullary nucleus of which, there exists a narrow conical hole, directed outwards, giving passage to the peduncles. The cerebellum of the bird represents indeed a vermiform process alone, and wants the lateral parts, which are superadded in animals more nearly allied to human beings in their anatomical construction, possessing in their place little germs or shoots scarcely discernible.

The successive additions, which may be traced to this simple form of a cerebellum, consist but of parts of similar structure with the elementary part; sometimes these cohere with the primitive portion, by continuity of their medullary substance alone, being otherwise separate and distinct; in other cases, the separation is slighter, and the new parts are continuous with the old, both through their medullary and their cortical substance; the former may be termed off-sets (ansätze), the latter wings (flügeln) of the vermiform process. Among the lower animals, there are but few and simple off-sets; higher in the scale, these become more numerous; the vermiform process extends itself laterally and receives wings, and in proportion as the wings are developed, the off-sets diminish. The first improvement in the cerebellum takes place at its anterior and upper surface; while on its under surface the parts remain contracted and shrunken. The vermiform processes predominate even in quadrupeds, in length, breadth, and depth; the fore part only of the cerebellum possesses distinct wings; laterally and behind, there are only off-sets. In proportion as the fabrick improves, the off-sets are changed into wings, till at length in human beings the hemispheres are completed; and with the exception of the flocks, the off-sets have wholly disappeared. All the parts are now brought together in compact order: the vermiform processes, with their wings, constitute one whole, between the parts of which the freest communication

seems to exist, which the employment of off-sets would interrupt.

In the brain of the hare there is little more than a vermiform process: there are but few wings, and these slight and short: the lateral off-sets are small. In the brain of the sheep the central lobe is large, firm, and broad, but has neither wings nor off-sets: the anterior velum is somewhat depressed upon the fourth ventricle. The next lobe in order is broad, of some length and depth, but has laterally short projections, not equal in their breadth to half the length of the vermiform process; these, however, may be viewed as wings. In the third lobe the organ is contracted, and has longer and larger wings; there follow, upon the under surface, a pyramid, spigot, and nodule, which have no wings, but a large bundle of lateral off-sets; between the wings and off-sets the peduncles of the annular protuberance emerge, and mark the place of the horizontal fissure. The whole cerebellum has a globular form, which results from the projection of the vermiform processes. The latter stand more or less vertically over the medulla oblongata, and have an anterior and a posterior surface, which correspond with the superior and inferior surfaces of the same parts in the human brain. The lateral off-sets in the higher animals are more and more driven from the fore to the back part of the cerebellum, until at length, in the human brain, they are exchanged for the lobes of the inferior surface, which unite with the inferior vermi-

form process. The whole cerebellum seems indeed pressed backwards, as its parts become more complex; so that the central lobe continually emerges more and more from between the peduncles of the tubercula quadrigemina, and in the human brain lies fairly behind these bodies, the common anterior stem being directed upwards, and the posterior horizontally. In the brain of the ox the central lobe is large, and without wings; the remaining lobes of the anterior surface are of inconsiderable dimensions: on the posterior surface, the pyramid, spigot, and nodule are barely separable; they are without wings, and have scarcely off-sets. Lastly, in the brain of the horse the central lobe is large, and without wings, but of less size than in the ox, and more compressed from above downwards. The next lobes of the vermiform process have anteriorly larger and longer wings, which are bent forwards, contracted in their middle, and at their ends have a club-like thickening. The upper and posterior lobe is distinct; but the under and posterior, the slender, the biventral, and almond-like lobes are wanting, and in their stead a large bundle of irregular off-sets is found on either side of the pyramid, the spigot, and the nodule.

Thus the enlargement of the cerebellum proceeds from the central primary portion; to which new processes, as wings or off-sets, are continually added, in proportion as the scale of its improvement rises. In quadrupeds, and even in the human brain, traces of

the simplest type of a cerebellum are to be seen in the central lobe, illustrating further the principle, on which its improvement proceeds. The furrow between this lobe and the lateral processes connected with it, is so deep, as to leave it doubtful whether the latter are properly wings or off-sets.

In the human brain the wings form the principal part of the cerebellum, viz. the hemispheres. On the upper surface these are immediately prolonged from the vermiform process; on the under surface they seem incomplete, being separated by a deep furrow from the inferior vermiform process on either side. It is remarkable that the human cerebellum, the most complex in its structure of any, should yet exhibit a resemblance of the clearest kind to the primitive and elementary form. When the human cerebellum is placed with its usually horizontal axis in a vertical direction, it may be rigorously compared with the cerebellum of birds: what in the latter case is a single lamina, is here subdivided, and has become arborescent; in the one case single leaves, in the other, lobes, lobules, and finally leaves, are raised around the nucleus, forming a dense investment to it, from under which the peduncles project on each side, like the fin-like feet from under the shell of the turtle.

In proportion as the lateral parts increase in the shape of off-sets or wings, the vermiform processes become smaller, as if compressed towards the centre. This circumstance is most apparent in the human brain: the vermiform processes are there compara-

tively diminutive in every dimension, in length, breadth, and depth: before them spring out the horns of the semilunar fissure, behind them the projecting margin of the purse-like fissure: within the latter, and at the place of the spigot and nodule, the inferior vermiform process is scarcely a few lines in breadth. In animals the vermiform processes overtop the lateral portions; in man the upper surface of the general commissure is only on a level with the hemispheres, while below it is contracted and shrunken to the bottom of the valley. This compression of the general commissure on all sides in the human brain, accounts for the difference observable in its structure as compared with that of the hemispheres; a difference which is not found in the brains of quadrupeds. In its texture this part in the human brain is softer, and its membrane firmer and more vascular than is the case in the hemispheres. The medullary matter is here again in thinner layers than in the hemispheres: thinly spread out in the anterior velum, it forms a thicker mass at the meeting of the vertical and horizontal process, where the nucleus of the general commissure begins: in the former process it exists in greater quantity than in the latter, and finally it forms an extremely thin layer in the posterior velum. In the anterior fissure the general commissure has its greatest breadth, becoming narrower as it passes towards the purse-like fissure: in the single commissure, where it has shrunk to a single lamina, and in the short commissure, it continues still narrow; it becomes

broader again at the pyramid, and finally tapers to a point in the spigot and nodule. On either side of the superior vermiform process there are furrows of greater or less depth, at which the laminæ are thinner, and indented, and their direction altered; so that whereas the convex margin of the laminæ of the hemispheres is directed backwards, that of the laminæ of the superior vermiform process looks forward. In these furrows, by which the lateral limits of the superior vermiform process are defined, blood-vessels are lodged: these furrows are continued along the valley, where they become deeper.

Looking generally at the vermiform processes, we observe that they are composed of corresponding portions on either side of the median plane, that there is no material difference in the structure of the upper and under portions, and thus that the whole is one homogeneous organ. We may observe further, that whereas in birds these parts constitute the whole of the cerebellum, and in quadrupeds the principal portion; in human beings, where their relative bulk is trifling, compared with that of the hemispheres, they are, on the one hand, parts of the same composition and nature with the latter, and on the other may be considered as the general commissure, by which the lateral portions are intimately united.

Explanation of the Third Plate.

Fig. I.

The first figure of this plate represents the appearance on the left side, resulting from a vertical division of the cerebellum in the median plane: it comprehends a section of the superior vermiform process, by means of which the square lobes are united, of the single commissure of the upper and posterior lobes, of the short and exposed, and of the long and hidden commissure, of the pyramid, the spigot, and the nodule, and of the fourth ventricle; this view is extremely instructive, and the care with which it is executed, will be evident on comparing it with Vicq. d'Azyr, Tab. XXV. Fig. 1, and Tab. XXIX. Fig. 3.

For this view the part is prepared in the following manner: when the cerebellum has been carefully stripped of its membranes, especially in the neighbourhood of the vermiform processes, it is to be placed in alkohol, its upper side downwards, the hemispheres resting upon two tolerably broad supports, which should lie parallel with the vermiform processes; the medulla oblongata is then to be somewhat raised, and the parts in the valley readjusted, if they have been displaced in the abstraction of the mem-

brane. When the Cerebellum is sufficiently hardened, a section is to be thus made: the medulla oblongata is to be cut through with a common scalpel in the direction of the basilar furrow, together with the tubercula quadrigemina; the knife will have passed through the aqueduct of Sylvius: the vermiform processes are now completely exposed. The division of these parts should be accomplished at one stroke; for which object, a long and very thin brain-knife, about an inch broad, and with a rounded end, is best adapted: to ensure perfect precision, a right line should be drawn on the surface of a table, a thread should then be placed carefully along the middle of the vermiform process, and the part so inverted, as that the thread should coincide with the line drawn on the table; the annular protuberance should lie towards the dissector; the knife should then be placed in the middle of the purse-like fissure, and drawn at once through the middle of the cerebellum, dividing it into two similar portions.

a. The Medulla Oblongata and the Annular Protuberance divided.

b. The Aqueduct of Sylvius, which leads under the tubercula quadrigemina to the fourth ventricle, divided.

c. The Tubercula Quadrigemina, covering the aqueduct of Sylvius, cut through in the median plane. In this section there is seen near the posterior margin of the tubercula quadrigemina, where the anterior medullary velum is attached, and immediately over the aqueduct, a hole of the size of a poppy seed, into

which on the left side a minute canal opened, through which a blood-vessel had probably passed. The section of the anterior velum follows; its passage from the posterior margin of the tubercula quadrigemina to the nucleus of the vermiform processes is seen; this process is medullary below, where it looks upon the fourth ventricle; above, it is composed of cortical matter, and marked with transverse furrows; in some brains it is smooth and medullary above. For the distance of a third of its passage from the tubercula quadrigemina, the posterior velum is inclined downwards, and forms the posterior part of the aqueduct: it then passes backwards, towards the vertical process of the general commissure, and unites itself at an acute angle with the middle portion of the posterior velum, so as with this to form the tent-like roof of the fourth ventricle.

d. The Central Lobe, the first branch of the vertical process, which lies in the semilunar fissure, with its anterior surface opposed to the anterior velum, and is divided into three branches.

e. The Vertical Process in its full dimensions, showing its manner of division. The entire section consists of the vertical and the horizontal process, which seem to allow of very trifling variations. The vertical process has always more medulla than the horizontal process; it is the medium of connexion between the portions of the square lobes, as far backward as their fourth lobules; hence it results that a deep furrow is found behind these fourth lobules, passing into the general commissure, and extending as far as its me-

dullary nucleus, and the roof of the fourth ventricle, and marking the interval between the vertical and horizontal processes. The vertical process has seven, and with the central lobe eight distinct branches, which serve as commissures to the anterior lobules of the square lobe; it has seldom more branches, sometimes the branch concealed behind the central lobe is wanting.

g. f. h. i. k. l. The Horizontal Process, the larger of the two, from which all the remaining branches are derived, which belong to the general commissure: in birds the vertical process is the larger, the horizontal process having scarcely germinated. In the brain of the hare the posterior branch is the larger, standing vertically, but with its point bent forward over the anterior branch. In the sheep, the nodule, the spigot, and the pyramid are very distinct on the posterior surfaee of the horizontal process: above, the germ of the commissure for the slender and posterior lobes, and upon the fore part, the short projections of the lobules of the square lobe are seen. The same points are noticed in the brain of the ox; the nucleus in this case is triangular. In the brain of the horse, the nodule, spigot, and pyramid are complete; at the summit of its cerebellum there are large processes for the slender and posterior lobes; on the other hand, the germs upon the fore part of the posterior lobules of the square lobe, are short and small: the anterior process has six branches, which do not, as in the human brain, arise from a common root, but all spring sepa-

rately and at an equal depth from the nucleus, which is large and round.

f. The Single Commissure of the Upper and Posterior Lobes; by means of which these lobes are easily distinguishable from those adjacent: this transverse band is the land-mark between the superior vermiform process, which lies above it, and the inferior vermiform process, which comprehends all the parts below: it is flat, and narrow, in the middle medullary, externally covered with a thin layer of cortical substance, without branches, and, it would seem, the direct continuation of the horizontal process. Sometimes, as in this case, the single commissure is not furrowed, and has a smooth surface on either side, which above is about three lines broad, below, somewhat more; sometimes, again, both surfaces, the upper and the under, are transversely furrowed, as is the case with the anterior velum; occasionally a lobule of the square lobe is found attached to this commissure.

g. Before and above the last described commissure, the horizontal process has the fewest branches; there being but four, and sometimes only three of these, which are small and deeply seated behind the vertical process, besides a fifth and more prominent branch, which again is subdivided into three; all these branches belong still to the square lobes, and complete the union of their posterior lobules.

h. The branch of the Horizontal Process, which lies immediately below the single commissure connecting the upper and posterior lobes. The laminæ of this

branch, which are visible in the purse-like fissure, and are five in number in this case, form the short and exposed commissure, by which the under and posterior lobes are specially united; these laminæ vary in number from four to seven; the laminæ of the under surface of this branch, which rest upon the upper surface of the pyramid, form the long and hidden commissure, by which the inferior lobules of the under and posterior lobe, and the lobules of the slender lobe are united: these commissural bands vary in number from seven to twelve; they may be exposed by depressing the pyramid.

i. The next branch is the Pyramid, the apex of which appears immediately below the short commissure. The upper surface of the pyramid is opposed to the long commissure; the under, to the spigot. It is here divided into three large twigs; by means of two or more cross bands it is connected to the biventral lobes, on either side.

k. The Spigot, divided into three minor branches, each of which is again subdivided: sometimes this part is smaller, and consists but of two branches; it is connected on either side with the almond-like lobes, by means of a transversely furrowed lamina, which gives attachment to the posterior medullary velum, being placed immediately behind the swallow's nest.

l. The Nodule is the last branch of the horizontal process, and the termination of the inferior vermiform process; at its outer margin it is slightly furrowed, in its centre divided into laminæ. The anterior surface

of the nodule is medullary, and is attached to the central part of the posterior velum, serving with the latter as commissure to its own lateral portions, and to the flocks.

m. The profile of the fourth ventricle, as it appears upon an accurate division in the median plane; its form is triangular, and what may be called its roof, tent-like. The medulla oblongata forms its floor; one sloping side is formed by the anterior, another, by the posterior velum. The nodule is in this case somewhat bent downwards, and on this account the ventricle appears larger than usual, where the medullary vela meet; laterally the ventricle is more roomy, from the inclination of the lateral portions of the posterior velum upwards.

FIG. II.

The central lobe of the Cerebellum, deprived of its cortical substance. In place of continued furrows its surface exhibits unconnected grooves, and the ridges between these grooves resemble in their manner of branching the nervous filaments of the eighth pair*.

a, a. The short wings of the central lobe.

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* Reil Exercitationum Anatomicarum, Fasc. 1. de Structurâ Nervorum. Halæ. 1796. Tab. I. Fig. 2, 3, 4, and 5.

c. The middle portion, or that belonging to the superior vermiform process, which is of remarkable bulk in proportion to the wings.

b. *b*. The places where the wings and central portion are connected. This is not effected in the manner of an off-set, for there is a true and entire communication; only the connecting isthmus is contracted, and without grooves or ridges.

Fig. III.

The central lobe from another brain, covered with its cineritious substance; on this account, instead of grooves and ridges, it has the usual linear furrows.

a. *a*. The two wings, in connexion with the middle portion.

c. The middle portion.

b. *b*. The Isthmus between the wings and central portion.

III.

Of the Posterior Medullary Velum in the Cerebellum.

So indifferently has Tarin * described the posterior velum, and he has represented it even worse, that it is

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* Tarin adversaria Anatomica. Parisiis, 1750. Tab. II. fig. 2. *n*. *n*. p. 8.

not wonderful that Haller* should have misunderstood his statement, and have expressed himself unsatisfied of the existence of this part: and although Malacarne† has since, and indeed with the merit of an original observer, given a complete account of the posterior velum, yet the existence of this part is not yet generally acknowledged. Some anatomists mention it always as a part of dubious existence; others quote previous descriptions of it, not having themselves seen it; nevertheless it is a part as clear and distinct as the anterior velum.

Tarin and Malacarne in describing the posterior velum employ the word flaps [klappen], and speak of two, one on either side. Malacarne uses the expression semilunar flaps, Tarin that of semicircular, inferior, and posterior flaps; but to speak more accurately, there exists a third or middle portion, which lies before the nodule, the three together forming one continuous whole: this whole I name the posterior medullary velum, and divide it into a middle slenderer and attached portion, and two lateral free and semilunar portions.

The two lateral portions of the posterior velum are perfectly alike: their substance is medullary, their structure membraniform, their epithelion that common to the fourth ventricle, their form semilunar, their

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* Haller. Elem. Physiologiæ, Tom. VI. p. 76.

† Malacarne. Nuova Esposizione della vera Struttura del Cerveletto umano. Torino, 1776.

convex margin adherent, their concave edge turned forward and unattached, so that it is easy to introduce a probe above either of them, and to carry it round its convex attached circumference. They have two extremities, an inner and an outer, at which the two margins join. Their outer extremities are attached to the internal sharp margin of the flocks, and pass along these bodies to the point, at which their first laminæ are given off. From either outer extremity the fixed and convex margin may be traced backwards to the root of the almond-like lobes; during the first half of this passage being adherent to the corpora restiformia: thence the convex margin passes under the peduncles of the tubercula quadrigemina, being attached all the way to a roller-like elevation of medullary matter which surrounds the posterior margin of the swallow's nest, and lies immediately before the furrowed commissural band, which passes from the root of the almond-like lobes to the spigot. The swallow's nests [schwalbennester] are semiglobular cavities, which are bounded behind by the root of the almond-like lobes, the furrowed commissural band, and the lateral surfaces of the spigot and nodule; before, by the peduncles of the medulla oblongata, and of the tubercula quadrigemina.

In its approach to the medullary lateral surface of the spigot and nodule, the convex and attached margin of the velum is inclined forward and downward; it then coalesces with the medullary stem of these parts.

The unattached margin of the lateral portion of the velum passes from side to side across the floor of the swallow's nest, below the peduncles of the tubercula quadrigemina and of the medulla oblongata. The superior surface lies unadherent in the swallow's nest, and the rounded extremity of the almond-like lobe rests upon the under.

Near its attachment to the nodule the inner extremity of either lateral portion of the velum is split into two laminæ; the posterior loses itself in the lateral medulla of the nodule; the anterior, which is from two to two and a half lines broad, passes across the fore part of the nodule, adhering to it by its posterior surface; its anterior surface looks to the fourth ventricle. This is the central portion of the posterior velum; the upper and posterior margin of which joins, at an acute angle, the anterior velum, immediately below the vertical process of the central commissure: the anterior velum is adherent to the medulla of the vertical process for a short extent before its union with the posterior.

All these parts, which look to the fourth ventricle, are naturally in close apposition: the cavity of the fourth ventricle is imaginary; but supposing its surfaces separated as by the presence of a fluid, the chamber containing such fluid would appear on a section through the median plane, of a tent-like form; the apex of the tent would be the meeting of the anterior velum with the posterior; its floor the medulla

oblongata; the uppermost of its inclined sides the anterior velum, and the lowermost the peduncles of the annular protuberance and the posterior velum.

For what object are the medullary vela intended? Both have an attachment to the same parts; both are of the same construction; both probably agree in function: one point is evident, that the posterior velum is in relation with the inferior portion of the cerebellum. In the brain of birds the posterior velum does not exist: in the hare its place is scarcely marked by a prominent line: in the sheep and ox the line has become membraniform; and lastly in the horse, the velum, particularly its middle portion, is fairly developed; it covers the anterior surface of the nodule as a medullary membrane lying over against the last lobule of the central lobe, which is covered with a similar membrane derived from the anterior velum. Either flock seems to be, as I have already remarked, the germ of an ill-developed lobe: the nodule may be their commissural portion; the union of which to the flocks is effected by the lateral portions of the velum.

In order to show the parts within the valley, and particularly the posterior velum and its connexions, a cerebellum stripped of its membranes, and hardened in alkohol, is to be thus treated: the square lobes are to be broken off from the peduncles of the annular protuberance as far as to the general commissure: it will then be easy to press together the hemispheres against the superior vermiform process, and thus to evolve the parts contained in the valley, so that the pyramid, the

spigot, the nodule, the swallow's nest, and especially the posterior velum, may come into view; then the biventral lobe may be removed from the under surface, the lateral portions of the hemispheres cut close off to the valley, the almond-like lobes pressed aside, the medulla oblongata divided at the posterior margin of the annular protuberance, and this latter part cut through longitudinally.

Explanation of the Fourth Plate.

Fig. I.

The Cerebellum is reversed, so that its under surface is seen.

a. The surface, from which the soft and biventral lobes have been removed, whereby the almond-like lobes are completely exposed.

b. b. The Almond-like Lobes of either side; the left is entirely, the right partly pressed outwards, and raised from its natural place; whence the left lateral portion of the posterior velum is seen in its whole extent, the right but partially.

c. The inferior and rounded end of the left almond-like lobe raised, which naturally is in apposition with the under surface of the lateral portion of the posterior velum. Between the rounded end of the left almond-like lobe *c*, and the spigot *f*, the transversely furrowed band

is seen, which passes from the almond-like lobe to the medullary lateral surface of the spigot.

d. The Medulla Oblongata, divided and bent forward.

e. The Pyramid.

f. The Spigot.

g. The Nodule bent downward.

h. h. The Flocks.

i. i. The Peduncles of the Medulla Oblongata, or corpora restiformia.

k. k. The under surface of the Peduncles of the Tubercula Quadrigemina.

l. The Anterior Medullary Velum; its inferior surface, which looks to the fourth ventricle, is seen.

m. m. The Posterior Medullary Velum, comprising the central and the lateral semilunar portions. The left lateral portion is entirely exposed, the right is partially covered by the almond-like lobe. The middle portion adheres to the nodule, and its inferior and anterior margin is alone seen. At the inner extremity of the lateral portions a fissure is seen, at which each divides into two laminæ; the posterior of which is continuous with the medullary substance of the spigot and nodule, while the anterior passes above the anterior and upper surface of the nodule, with which it coheres.

Fig. II.

The posterior surface of the Nodule, which naturally is in apposition with the Spigot. There are seven laminæ on this surface: on either side, and attached to this, lie the two semilunar lateral portions of the posterior velum.

a. a. The point at their lower margin, where the lateral portions divide into two laminæ.

Fig. III.

The Nodule pressed downwards and backwards, so that its anterior and upper surface is seen: its apex, looking naturally towards the medulla oblongata, is grey. The base of this surface of the nodule is medullary: the posterior velum is seen adhering to it.

a. a. The point, at which either lateral portion divides into two laminæ.

b. The anterior laminæ of the middle portion of the Posterior Velum.

c. The apex of the Nodule, from which may be counted four laminæ forwards: next is seen an uniform grey surface without furrows; and lastly, the medullary middle portion of the posterior velum.

FIG. IV.

The Posterior medullary Velum, with the nodule completely reversed, so that the upper surface of each is seen.

a. a. The anterior free margin of the lateral portions.

b. b. The outer extremities of these, by which they cohere with the medullary stems of the flocks.

c. c. The posterior and upper convex margins of the lateral portions, which adhere to the margins of the swallows' nests.

d. The middle portion of the Posterior Velum, which passes before and above the nodule, to the root of which it is attached, joining at an acute angle the anterior medullary velum, which reaches the same line. The upper or anterior surface of the nodule is opposed at its base to the anterior medullary velum, at its apex to the medulla oblongata.

Further Inquiries respecting the Structure of the Human Cerebellum, by Professor Reil. Archiven für die Physiologie. Achter-band, p. 273—304.

IV.

Of the Vertical Section through the Middle of the Hemispheres of the Cerebellum.

From the medullary nucleus of the hemispheres, and of the general commissure, the processes, which are to form lobes, lobules, and their further subdivisions, are given off in a radiated manner, encircling the nucleus above, below, behind, and in an unbroken series from the anterior medullary velum to the posterior: their extreme subdivisions, clothed with cortical matter, form the laminæ visible on the surface: these are disposed parallel with each other, and those of either side are united by means of the laminæ of the general commissure. On the upper surface of the cerebellum, the laminæ are disposed in an uninterrupted curve from side to side, the superior vermiform process concurring to form the here indented segment: at the posterior margin, and on the under surface, the curves are completed in each hemisphere, extending from the horizontal fissure of either side to the general commissure; with which, in the valley, the hemispheres are united in a less perfect and uniform manner.

The deep furrows, by which entire lobes and primary processes of the medullary nuclei are separated, are as uniform in different individuals, as the arrangement of the peduncles and the origins of the nerves; but the ramifications of the medullary stems, the subdivisions of the lobes, the number, form, and direction of the laminæ have no constant disposition. The minute description of the final laminated terminations of the lobes, which Malacarne has given, is erroneous as a general account, inasmuch as it is not applicable to a second specimen.

The shallower furrows, which intercept the smaller and subordinate portions, do not pass uniformly from one horizontal fissure to the other: at the posterior margin of the cerebellum, their continuity is fairly broken up, and even on the upper surface it is not uninterrupted, in consequence of the occasional union of the laminæ, which take their rise from one stem. The ultimate laminæ are separated, some by slight indentings, others by well defined furrows; some have a sharp margin, others, particularly those upon the surface, have a broad and rounded margin: some continue single throughout, others unite by pairs, form insulated portions, or distribute themselves arborescently. Upon the upper surface of the cerebellum, the laminæ are disposed more or less concentrically with the general direction of the lobes; laterally they pursue various courses, sometimes dipping obliquely inwards below the level of the neighbouring portions. The arrangement of the laminæ, when stripped of their

cortical matter, bears a great resemblance to the retiform and arborescent appearance of nerves, when deprived of their neurilema: but in the former case the impression merely amounts to a furrow, whereas in the latter it is continued through the substance of the part. It would be interesting to trace the developement of this structure in the nerves of the embryo: there can be little doubt, but that in the brain, the object of this subdivision of the surface, is to gain more space for the extension of the cortical matter.

In order completely to understand the disposition of the nuclei and of the medullary stems in the cerebellum, it is necessary to compare the section of the general commissure with that of either hemisphere; in these sections there is seen an entire difference in the branching of the stems from the nuclei, yet still a provision may be traced for the gradual conversion of the one mode into the other.

In the fifth plate, which is adjoined, a vertical section is given of the left hemisphere of the same brain, which furnished the section of the vermiform processes in plate the third. The mode of branching, as shown by this section, and which alone I had in view, is accurately delineated, though the form of the entire part is not perfect: the whole cerebellum, for instance, is too much flattened, and the roundness of the upper and under surfaces is lost, owing to the position of the part in the vessel in which it was hardened.

Either hemisphere, considered apart, resembles a pyramid, the base of which is behind and below, the apex before and above: we may distinguish two margins, two sides, two surfaces, and four angles in each hemisphere: of the two margins, the anterior is concave, being nearly one half of the semilunar fissure, and marking the mutilated summit of the pyramid; the posterior obtusely rounded margin skirts the base of the pyramid; the inner side is parallel to the vermiform processes, with which it for the most part coheres, being however unattached in the purse-like fissure, the lateral wall of which it forms; the outer side is entirely free, and parallel with the horizontal fissure; the upper surface is slightly curved, the under hemispherical; the former comprises the square and the upper and posterior lobes, the latter, the under and posterior, the slender lobes, the biventral and almond-like lobes: of the four angles the anterior and outer is free, being the extremity of the semilunar fissure; the anterior and inner unites with the fore-part of the general commissure: the posterior angles are both unattached and rounded off; of which the outer is supposed to exist at the meeting of the outer side and posterior margin, the inner at the extremity of the under and posterior lobe in the purse-like fissure.

The section is so made as to divide the hemisphere vertically through the middle of either margin: in this manner all the lobes and lobules, with the exception of the biventral lobe and the almond-like lobes, are justly

divided in their axes. The same process should be employed in this case as in dividing the general commissure: it is expedient to place the cerebellum on its upper surface, to incline the knife somewhat outward, and to carry it at one stroke from the fore, through the back part of the hemisphere.

The section begins at the hollow between the crura cerebri and annular protuberance, passes obliquely through the latter, divides the portio dura of the seventh, and the auditory nerve, the medullary stem of the flock, and the outer extremity of the semilunar lateral portion of the posterior medullary velum. The section passes across the outer part of the swallow's nest, through the corpus restiforme touches the root of the almond-like lobe, and cuts obliquely through the point of the biventral lobe; in continuation, it divides the square lobe, the upper and under posterior lobes, and the slender lobe: it divides, besides, the nucleus of the hemisphere, and the corpus ciliare contained in it, the peduncle of the tubercula quadrigemina towards its outside, the tubercula quadrigemina, and the crus cerebri.

Explanation of the Fifth Plate.

Fig. I.

A section of the left Hemisphere of the Cerebellum; the external portion is that represented.

a. b. c. The Crus Cerebri, Tubercula Quadrigemina, and Annular Protuberance, obliquely cut across from within outwards, and from before backwards.

b. The hole between the crura cerebri and the anterior margin of the annular protuberance.

d. The divided Portio Dura.

e. The divided Portio Mollis.

f. The divided stem of the Flock, to which the lateral portion of the medullary velum is attached externally.

g. 1. The external part of the Almond-like Lobe, which is attached in the valley to the spigot, cut through.

h. i. 2. The Biventral Lobe, which is divided more obliquely; 2. the medullary stem; *h.* the anterior portion, curved towards the medulla oblongata, and touching the flock and almond-like lobe; *i.* the posterior portion, adjoining the slender lobe.

k. l. 3. The Slender Lobe, which unites itself to the pyramid in common with the biventral lobe; 3. its stem, which quickly divides into an anterior and posterior branch.

m. n. 4. The Under and Posterior Lobe; 4. its short medullary stem, dividing into two branches, *m.* the anterior, *n.* the posterior, connected in the valley with the long and the short commissure. In some brains this lobe has two stems projecting from the nucleus, of which the posterior is the largest, and divides into two branches.

o. p. 5. The Upper and Posterior Lobe; 5. its large

medullary stem, which divides into two principal branches, *o.* the posterior, and *p.* the anterior. The single commissure, composed of a single lamina [tab. iii. fig. 1. *f.*] unites the two lobes of this name, which have the longest and largest stems of any of the lobes of the hemispheres; sometimes this lobe enlarges at once, from its connexion with the commissure; sometimes its thickening is gradual: its section is broadest near the horizontal fissure.

q. r. s. 6—13. The Upper and Anterior or Square Lobe: this lobe has eight [6. 7. 8. 9. 10. 11. 12. 13.] medullary stems rising from the nucleus, whereas the other lobes have but one: these numerous stems, however, are individually slighter than the stems on the under surface and posterior margin. Sometimes there are but six or seven medullary stems to this lobe, which are in that case larger, and have more numerous branches. Where the square lobe borders on the upper and posterior lobe, between *p.* and *q.* and 5. and 6. may be remarked always one, sometimes two small and short stems, which do not appear at the surface, but fill up the angle, which results from the great inclination backward of the square lobe, compared with the direction of the upper and posterior lobe: at *r.* is the limit at which the vertical process of the general commissure is separated from the horizontal process: four stems are found on either side of this interval. The furrow between the vertical and horizontal process of the general commissure is deepest at the central point, through which the section in the median plane

passes; here the furrow reaches the nucleus; but on either side it becomes shallower, so that in the section of the hemisphere, the distinction between the vertical and horizontal branch is lost, and the furrows between each of the lobules of the square lobe are all equally deep.

1. The nucleus of the hemisphere, with the corpus ciliare in its middle, which, in the section of the general commissure, is a point only, where the vertical and horizontal processes join, but here is enlarged to considerable dimensions both of height, and length, and breadth: hence the altered relation between the medullary stems and the nucleus: in the general commissure there are but two processes; in the section of the hemisphere there are from ten to thirteen, rising from the nucleus. Behind 6. and 2. behind the square lobe above, and the biventral lobe below, the nucleus becomes much smaller, and is compressed and flattened from above downwards, so that it might indeed here be considered as a stem, of which the upper and under posterior lobes [3. 4. and 5.] are branches.

1.—13. Are thirteen medullary stems, which are seen in this section to spring from the nucleus of the hemisphere: of these 4. and 5. appear the largest, 5. the longest: 1. and 2. the stems of the almond-like lobe, and the biventral lobe, are also large, but they are not fairly seen in this drawing. When these lobes are cut through vertically in their axes, as in fig. II. and III. the stem of the almond-like lobe is seen to be of con-

siderable size, and that of the biventral lobe to be divided down to the nucleus.

The medullary stems vary in number from ten to thirteen: there are seldom fewer than ten. When the number is small, the loss falls on the square lobe. When the stems are numerous, they are individually smaller, and have fewer branches; on this principle the stems in the square lobe are many and simple. In the right hemisphere of the same brain the anterior branch of the soft lobe was slightly furrowed and larger, and the under and posterior lobe was proportionately smaller and less arborescent: the upper and posterior lobes were like those on the left side: the square lobe had eight stems, but the interval between the vertical and horizontal process fell, in this case, behind the fifth stem, as it more generally happens.

Fig. II.

In the vertical section of the hemisphere the biventral lobe is obliquely divided: in the present figure a vertical section of a biventral lobe is represented, carried through its thick and outer extremity, and parallel to the horizontal fissure: either venter in this view has its proper stem rising immediately from the nucleus.

a. A portion of the nucleus, from which the two stems of the biventral lobe spring.

b. The internal stem, which is in apposition with the almond-like lobe and the flock: this is the larger stem, and divides into two branches.

c. The external slighter stem, which leans against the slender lobe.

Fig. III.

The situation of the almond-like lobe is so near to the median plain of the cerebellum, that in the vertical section of the hemisphere, a small external portion only of this lobe is shown. To exhibit the interior of this part in its full dimensions, the lobe should be divided from its point to its base: such a section passes through the stem of the almond-like lobe, the lateral portion of the posterior velum, the swallow's-nest, and the peduncle of the tubercula quadrigemina. The large stem of the almond-like lobe is somewhat contracted near its root; afterwards it expands into an irregular rounded extremity, from which three branches spring, which divide themselves again into minor branches and laminæ.

a. a. a. The peduncle of the Tubercula Quadrigemina, and its continuation with the lateral portion of the posterior velum, through the nucleus, where it contributes to form the upper side of the fourth ventricle, and receives the rounded end of the almond-like lobe in the cavity termed the swallow's nest.

b. The divided lateral portion of the Posterior

Velum, which lies in the swallow's-nest, between the under surface of the peduncle of the tubercula quadrigemina, and the rounded end of the almond-like lobe; *b.* the rounded end of the latter somewhat depressed, in order that the posterior velum may be more distinctly seen, and its manner of connexion with the nucleus.

c. The Nodule.

d. The medullary stem of the Almond-like Lobe, which is directed obliquely upwards and backwards towards the nucleus.

e. e. The convex unattached extremity of the Almond-like Lobe, which looks towards the valley and the medulla oblongata.

f. The apex of the lobe.

g. The side, at which it touches the biventral lobe.

1. 2. 3. Three branches of the stem, of which the slightest, 1. is divided into three portions; the shortest and broadest, 2. into two portions; and the longest, 3. into several.

V.

The Cerebellum separated from behind forwards into two horizontal Portions.

For this object it is necessary to employ a cerebellum thoroughly hardened in alkohol. The separation is effected by tearing the organ asunder at the interval

riations, exists in every brain. I will endeavour to describe this as clearly as I can, and I request the reader, for the better understanding my description, to compare it with the adjoined drawings, and with a preparation such as I have employed; he will find, however, after all, that this inquiry will suggest to his mind many more doubts respecting the structure of the cerebellum, than it will clear up. The internal structure consists of fibres, tending from the circumference to the centre: at the circumference the fibres are fine, towards the centre, coarsely fasciculated. The whole exposed surface is naturally divisible into five regions, in which there is an obvious difference of structure. The finer fibres, converging towards an imaginary centre, compose all the stems, which rise directly from the nuclei, as well as their branches and further subdivisions: coarser fibres, on the other hand, more or less interwoven with one another, compose the nuclei. In the preparation, from which the adjoined drawing was taken, the fibres of the nuclei appeared to follow the same general direction with those of the stems: mostly, however, the fibres of the nuclei are bent away in the horizontal plane from the point, at which they touch the radiated fibres of the circumference, so as to form at first an angle with the latter: the tendency to decussation, which chiefly occurs in a direction parallel to the median plane, increases as the coarse fibres are more remote from the circumference, and approach the peduncles, which seem to have a like structure. Traced

along the fine radiated fibres of either surface, and parallel to the circumference, may be seen a ridge, and a light groove or indented line; upon the under surface the ridge is external, and the furrow internal; the reverse is noticed upon the upper surface: the furrow upon the under surface and the ridge upon the upper, mark the meeting of the stems and nuclei.

In the outer region on either side [Tab. VI. Fig. 1. *e. f. e. f.*] the fibres are arranged in four strong fasciculated bands, which decussate each other; a finer disposition, but of a similar kind, seems to prevail in the bands themselves. In the next region on either side, [Tab. VI. Fig. 1. *f. g. f. g.*] the direction of the fibres is more uniform, except where towards the inner margin a round fasciculus ascends obliquely between these fibres, which form a cylindrical canal enclosing it: this fasciculus extends below towards the swallow's nest and the almond-like lobe, on either side. In the middle region [Tab. VI. Fig. 1. *g. g.*] which corresponds to the general commissure, the fibres are throughout fine and uniformly disposed, but are somewhat less so in the nucleus; one fine transverse line alone occurs in this region, at the union of the pyramid with the horizontal process; this line is a slight furrow on the lower, and an equally slight ridge on the upper surface.

Thus the peduncles of the cerebellum are shown to be prolonged backwards in coarse and interwoven fibres which encircle the ciliary bodies, and form the nuclei,

from the surfaces of which a series of finer and radiated fibres, corresponding with the lobes and their subdivisions, diverge.

Explanation of the Sixth Plate.

Fig. I.

The Cerebellum, torn horizontally into an upper and under portion: the medullary surfaces resulting from this division are represented.

A. A. The upper portion of the Cerebellum.

B. B. The under portion.

C. C. The Purse-like Fissure.

D. The posterior surface of the Single Commissure.

E. The upper surface of the Branch *h*, [Fig. 1. Plate III.]

F. F. F. F. The Cortical Substance of the last, and of the last but one of the Lobules of the upper and posterior Lobe, between which the separation is accomplished.

G. G. The projecting inner extremity of the Under and Posterior Lobe.

a. a. The Furrow on the upper portion.

b. b. The Ridge on the upper portion.

c. c. The Ridge on the under portion, which corresponds with the furrow *a. a.*

d. d. The Furrow corresponding with the ridge *b. b.*

b. b. d. d. The lines, within which are the nuclei, without which the stems and their subdivisions; the fibres in the former are coarse and intricate, in the latter uniform, fine, and radiated.

By the lines *e. f. g.* are indicated three regions, in each of which a different organization is observed.

e. f. e. f. f. e. f. e. include the outer region.

h. i. k. l. l. k. i. h. Four strong bands on either side in this region, which cross each other in the substance of the cerebellum, and are themselves composed of fibres similarly disposed.

f. g. f. g. g. f. g. f. The following region on either side, which is placed above the swallow's nest, and has a peculiar structure.

m. A point, from which a bundle of fibres ascends obliquely backwards.

n. o. n. o. The medullary cylinders, and the channels, in which they are lodged; the former are torn across.

g. g. g. g. The internal or middle region, which consists of the rent surfaces of the general commissure.

p. p. A line, at which the under surface is transversely furrowed, and the superior marked by a slight ridge.

q. The fine decussation of the fibres at the bottom of the fissure in the middle region.

Fig. II.

In this figure are represented the cylindrical medullary bodies, which are found on the inside of the region *f. g. f. g. g. f. g. f.* [Fig. 1.] as they appear before the separation above described is completed, which eventually tears them across.

a. a. The upper half of the Cerebellum.

b. b. The under half.

c. c. The Purse-like Fissure.

d. The anterior and upper surface of the branch *k.* [Plate III. Fig. 1.]

e. The posterior surface of the Single Commissure.

f. f. Portions of the Regions marked *f. g. f. g. g. f. g. f.* in the preceding figure.

g. The middle Region.

h. h. The cylindrical medullary bodies, which rise from the under surface in a direction different from the course of the neighbouring fibres, whence they appear to lie in proper canals; they ascend obliquely backwards, and pass to the cortical substance of the commissure of the upper and posterior lobes.

Further Inquiries respecting the Structure of the Human Cerebellum, by Professor Reil. Archiven für die Physiologie. Achter-band, p. 385—426.

On the Structure of the Lobes, and Lobules, and Laminæ, which are placed upon the medullary Nucleus of the Cerebellum.

VI.

The value of these inquiries turns upon the question, whether the structure which I am about to describe exist originally in the organ, or result from its induration in alkohol. Upon this point I shall only observe, that the definite and peculiar arrangement of parts which is found in the hardened cerebellum, appears unlike what we might expect to arise from the influence of a chemical agent upon an uniform pulp; and that it is much more probable, that immersion in alkohol merely unfolds and renders evident an original separateness in the component parts of the brain, which was before too delicate for observation.

To resume our description: the three peduncles on either side may be considered as forming, by their union, two medullary columns, which are directed at first backward and outward; these enlarge into coarsely fasciculated masses, which contain, near the middle of each hemisphere, the ciliary bodies, and are finally in-

clined inwards in a circular course towards the general commissure; the central mass on either side is surrounded by a laminated stratum, and, in union with the latter, constitutes the medullary nucleus: upon the exterior or laminated stratum the lobes and their subdivisions are placed: in the history of the latter two distinct points claim our notice, viz. the structure of each part, and the manner of its articulation with the neighbouring surface. As the same plan is every where followed in these respects, the complete understanding of any single portion of the surface involves a knowledge of the whole.

The lobes, lobules, and their subdivisions, consist of medullary plates, which are arranged in succession, one behind the other, and are parallel to the outward furrows; each medullary plate again consists of fibres, which are radiated, and converge from the circumference, generally towards the centre of each hemisphere, as seen in Plate VI. Fig. 1 and 2; but sometimes, as in the almond-like lobes, another imaginary centre is produced by the peculiar form of the part, towards which its fibres converge. In the stems and branches of the lobes, that is to say, when nearer the nucleus, the fibres are found to be coarser and stronger than at the surface of the cerebellum.

In consequence of their radiated structure, the medullary plates tear very readily in the direction of their fibres, but do not yield any regular fissure, when an attempt is made to tear them transversely. The

fibres have a glittering, bubble-like appearance, when viewed through a microscope.

In brains which have been long in alkohol, and appear thoroughly hardened, threads as fine as those of the silkworm may be raised from the stems, particularly in their middle: whether the substance of these threads correspond in any respect with the cellular texture between the fibres of muscles, is extremely uncertain.

The particular contrivance, which I call an articulation [articulation], exists, wherever subdivision or branching occurs, as of the stem from the nucleus, or of branches from a stem, as well as when a slighter medullary layer lies upon a larger: it may be mentioned here, that the parts of the cerebellum are rather contiguous to, than continuous with, each other: the truth of this position will appear in the sequel. The articulations are disposed in lines parallel to the course of the laminæ, and consist of a projecting linear ridge on one surface, and a corresponding furrow on that opposed to it: the ridges are more or less acute or rounded: the surface between any two ridges is slightly hollowed. The appearance of ridges and furrows has been already represented in the drawing of the horizontal rent of the cerebellum. It is necessary to distinguish from this mechanism those sharp and minute projections which exist in the angle, at which any two branches of equal bulk meet; such projections are acute, and consist of two portions adhering without

an intermediate furrow. Every lamina is naturally separable into two equal lateral portions: at the centre of the base of each lamina is found an angular furrow, which receives the ridge of the surface below. If a lobule be divided in its axis, and from the exposed surface of either half, the medullary plates be successively raised in a direction from the base towards the apex, to that, on which the ridges exist for the articulation of the laminæ; and this last lamina, instead of being raised as the preceding, be peeled off crosswise, medullary plates are seen extending from the ridge into the centre of the lamina. Similar ridges exist on other occasions where medullary plates are joined: the ridges are slighter, in proportion as they are remote from the nucleus. A rent made from the outer surface of a lamina towards the centre, does not pass directly to the nucleus, but from the lamina, through the branch on which the latter is placed, from this branch again through its stem, and so on towards the nucleus. The middle medullary plates of the laminæ do not pass to any adjoining branch, but are continued down the branch on which the lamina is placed. A similar disposition is observed in the connexion between minor branches and larger branches, and in that between the latter and their stems: the exterior plate alone skirts accurately the margin of each subdivision, and may be traced reascending, and lining in succession those beyond: the internal plates follow the course of the stems and branches. These facts may be ascertained when a

lobe is opened from its base and everted. The medullary plates of the stems pass into the branches and their subdivisions, and even into the laminæ.

Having made these general remarks, I will describe specifically each part, beginning at the circumference, and passing inwards to the nuclei: and first of the laminæ*.

The cortical external covering of the laminæ consists of two layers; the outer of which is grey, the inner of a dirty yellow. The outer layer may be removed from the inner, and the inner again from the medulla, leaving smooth surfaces, and apparently without the rupture of an intermediate substance. By immersion in alkohol the cortex becomes white, the

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* By laminæ [blättchen] I mean the ultimate subdivisions of the lobes of the cerebellum, which are composed of a central medullary, and an external cortical portion; for the most part they project at an acute angle; they vary in form, magnitude, and direction. The cortical matter is not confined to the laminæ, it is equally spread over the furrows between them; it is however limited to the surface, with the exception of its contributing to the ganglions within the medulla. The medullary substance of the cerebellum again is every where covered with cortical matter, excepting on the surfaces of the fourth ventricle, the stems of the flocks, the medullary vela, and the peduncles; which parts, it may be presumed from this circumstance, have an office different from the rest.

medulla yellowish, but more so in the laminæ than elsewhere. The cortex is of a looser, more spongy texture than the medulla. These circumstances, and what I have mentioned above, of the continuity of the layer of medulla immediately within the cortex, may lead to the conjecture that the latter is formed as if by precipitation from the investing pia mater, and that its colour changes gradually to yellow, and then to white; and it may even be worth inquiry, whether the whole substance of the cerebellum be not thus formed. One circumstance I would mention in connexion with the preceding remarks, that the pia mater in the fœtus is unusually firm, when there is no distinction between cortex and medulla in the substance of the brain.

The central part of the laminæ consists of slender plates, which lie in close apposition, and admit of being separated. These plates are composed of fibres, which are nearly parallel, are directed towards the extremity of the laminæ, and are covered on every side with cortex. The external plates are reflected from one lamina to another. If the external plates be followed to the centre of the base of any lamina, from the interval on either side intervening between this lamina and the next above and below, they will be found to meet abruptly; and at an angle with their former course, and parallel with each other, and in the axis of the lamina, to pass to its extremity. Where these plates meet is the angular furrow belonging to their articulation, beginning at which it is easy to separate the lamina into two equal and similar portions.

Intermediately between the external plates thus described, other medullary plates, derived from the medulla of the branch itself, enter each lamina, which may be distinctly traced for at least half of the length of the lamina.

From the lateral surface of a lobe or lobule, lamina after lamina may be successively removed with the handle of a scalpel and the forceps: along with each lamina a medullary plate is torn down; the first of which, that namely corresponding with the lamina nearest the base, may be traced reflected along the opposite surface of the adjoining branch. At the point where the lamina is first raised, and at the place of its natural articulation, a ridge is seen: if the next lamina be raised, another ridge is seen, belonging to the articulation of the second; and if this be then drawn towards the base of the lobe, along with its corresponding medullary plate, the ridge is lost, on which the former lamina had been placed, but remains still distinct upon the plate last separated. In this manner the laminæ on each side of a lobule may be removed to the central plates. Every lamina, however, does not bring away with it a medullary plate: whether it be, that all the laminæ have not a plate derived from the centre of the branch, or, that if they have, its slightness renders it often impossible to remove it singly. Thus a lobule is peeled from the outside to its central plate, much in the manner of various parts of plants.

If a lobule be selected, the laminæ of which pass off

at a right angle nearly, and one of these be pressed towards the apex, and upon its thus exposed surface a slight incision be made, the thin medullary plate, which may then be raised, will not pass from the base of the lamina along the axis of the lobule; but will be found continuous with, or reflected so as to form the outer medullary plate of the lamina next in order towards the base of the lobule. A similar result ensues, if an incision be made upon the external margin of a sufficiently broad lamina in the direction of its axis, and either lateral portion be pressed towards the adjoining lamina; the separation will continue down the first parallel to its axis, and then ascend the second lamina in the like direction. If again the cortical matter be removed from a few laminæ, and from one surface of a thus denuded lamina a fine layer be drawn with the forceps, the rent will first descend parallel to the axis of the denuded lamina, then run at an angle along the interval leading to the next lamina, which it will in turn ascend.

If a thin lobule be torn asunder in its axis, and its layers be raised in a direction from the base towards the apex in succession, so as to leave the external layer only, there is an appearance as of cylinders lying in close lateral apposition: the projections in this case correspond with the intervals between the laminæ; and the angular furrows, to the axes of the laminæ: each lamina will open at these furrows, and finally divide into two equal portions. If care be taken not to complete this separation, each lobule, and even each entire

lobe, may in this way be unfolded, and its arborescent appearance converted into that of an expanded membrane. The better mode of thus unravelling a lobe is the following: a portion about an inch broad is to be cut out of a fresh cerebellum, and placed for from twelve to twenty-four hours in a weak solution of caustic potass, then in distilled water for some hours more, and finally left for from twenty-four to forty hours in pure alkohol. Very little force is necessary to unfold the parts of such a preparation in the order above described. By a somewhat similar process the medullary plates of the lobes and lobules may be shown: an indurated cerebellum is to be placed in a weak solution of caustic potass, for from twenty-four to forty-eight hours, and subsequently reimmersed in alkohol for a few days, if the solution of potass has rendered it too soft. From a lobe thus prepared, the laminæ, with their adherent medullary plates, may be easily separated in succession. When several laminæ have been removed, it may well be seen how one or more plates of the central medulla of each lobule enter the furrow at the base of each lamina, and proceed towards its margin. The same observation may be varied by drawing off, in the direction of the furrows, the external medullary plates. If a lobule be split from its base, the fissure does not always proceed to the circumferental extremity, but often breaks short off into the centre of a lamina.

The composition of the lobes and lobules is accurately the same as that of the laminæ; only that the

medullary axes of these larger parts are larger in proportion; but they equally admit of a central division, and their outer layers are reflected in a similar manner along the opposite surfaces of the adjoining similar parts. For the articulation of a branch with a stem, a lobule with a lobe, the latter shows at the line of separation a slight projecting ridge, which is received into a furrow in the latter. If the square lobe be broken off from the nucleus, and the laminated stratum be peeled from its internal surface, an appearance of apposed cylinders, or of parallel raised surfaces, with intermediate furrows, is seen; resembling, though on a larger scale, the internal surface of the laminæ. The entire lobe may be then unfolded, the separation commencing at the intermediate furrows: the parallel raised surfaces again correspond to the intervals between the lobules; they are not always rounded, but sometimes angular and wedge-like. Finally, the lateral plates of the lobules are reflected to the opposite sides of the neighbouring lobules, and the entire lobe itself, as well as the lobules, laminæ, and their investing cortex, seem as if they might be the result of successive depositions from the surface. Hence it is that rents from the circumference toward the centre do not penetrate the nucleus, with the exception indeed of that carried between the upper and under posterior lobes, which is represented in Fig. 1. Plate VI. In this case the rent is successfully carried through, in consequence of striking an interval between the circularly disposed fasciculi, which enclose the ciliary

bodies: the rent has every appearance of doing violence, and the radiated fibres of the lobes meet those of the nucleus at an angle.

The lobules are articulated by means of ridges and furrows with the nucleus. To the square lobe there are mostly but three strong ridges, and several lobules attach themselves to the anterior of these; hence the ragged appearance of this ridge, when the lobe in question is broken off. When the square lobe is raised from the horizontal fissure towards the superior vermiform process, a similar appearance is seen to what occurs in stripping the medullary plates cross-wise from the laminæ; viz. that of medullary plates entering the central furrows from the ridges, which correspond with them.

From what has been said it appears, that in the structure of the lobes, plates composed of medullary fibres are merely laid in successive layers upon the nucleus; a remark which is confirmed by these additional facts; that there is no relation between the volume of the hemispheres and that of the medullary columns; that the medullary substance of the branches does not diminish in proportion to the minor branches given off from them; that the radiation in the lobes has in many places a different direction to that in the nucleus; and lastly, that the lobes and lobules of either surface overlap the medullary columns on either side of the horizontal fissure. It appears that the fibres from the circumference crowd together towards an imaginary centre, and thus exhibit internally an ir-

regularly fissured surface, when they reach the nucleus, the next part for our consideration.

Immediately within the lobes a laminated stratum exists, which forms, on the one hand, the surface supporting these processes, and on the other, the exterior shell of the nucleus. This it is, which requires to be peeled from the internal surface of the square lobe, after its removal, as above alluded to, in order that the alternate risings and furrows at the base of its lobules may be seen. I have been able frequently to raise two, three, and more medullary plates in succession, between one ridge and another, especially between the posterior ridges. It would seem as if the component fibres run across each intermediate furrow, and meeting, form each ridge, and mount together into the lobules. There are found, besides, some coarser fibres in the direction of the ridges, which cannot be raised without breaking up their adhesion to the sides of the medullary columns; perhaps these are but layers, which serve to fill up the intervals: the stratum itself seems, as the preceding parts, to be formed in layers, as by successive depositions.

The last part is the stratum of coarse and curvilinear fasciculi, which is specially continuous with the lateral peduncles of the cerebellum, and together with the anterior and posterior peduncles and the ciliary body, constitutes the central part of the nucleus of either side. The lateral peduncles ascend backwards and outwards in the horizontal fissures, expand them-

selves in the upper and under portions of the hemispheres, and at the same time incline inwards, being curved more abruptly at the fore part than near the posterior margin. The anterior division of fibres throws itself over the anterior peduncles, and with the next set pursues a course towards the general commissure: a third set of fibres passes parallel to the medulla of the general commissure, towards the purse-like fissure, to the posterior margin of the posterior lobes, the radiated fibres of which are placed at an angle upon them. If, on the removal of a portion of the posterior lobes, part of the nucleus is brought away besides, the two portions either naturally separate, or are only retained by their mutual indenting, the furrows for which are parallel to the circular course of the fibres of the nucleus. Between the middle peduncles, which form the capsule of the ciliary body, (which consists of lobes again, and may be raised from this capsule) and the anterior peduncles, the posterior plunge; and along with the middle peduncles, mount over the anterior. The anterior peduncles pass directly backwards, pierce the lobes of the ciliary body with delicate fibres, and lie close upon and parallel to the anterior velum, and the nucleus of the general commissure. On another occasion I propose to return to this subject, and to give a fuller account of the nucleus and its peduncles.

Explanation of the Plates.

Plate VII.

Fig. I.

This engraving represents the surface exposed by tearing off the square lobe, which is effected in the following manner. Its anterior angle is first raised by means of the handle of a scalpel, from the peduncle of the annular protuberance, and then the whole external margin of the lobe is carefully detached as far as the posterior angle; in general, a portion of the upper and posterior lobe is raised along with this: the fissure thus begun, is continued towards the general commissure, by continually raising the partially detached lobe with the finger or the handle of the scalpel: during this process, the ridges are brought into view, with which the lobules of the square lobe are joined, and towards the vermiform process the yet unbroken medullary plates are seen rising from the ridges and entering the lobules. On either side of these medullary plates are fissures separating them from the outer plates, which, if enlarged with the handle of the scalpel, show more distinctly the rise of the central plates,

in the middle of the lobules: the lobe may now be broken abruptly off, close upon the general commissure.

The shallower the layer, which is thus raised, the more distinct is the appearance of the ridges, on which the lobules rest, of the outward sloping furrows, which lie between these, and of the fissures in the centre of the lobules. The surface thus exposed, consists of the laminated stratum, which lies above the nucleus. The layers are piled most thickly anteriorly, towards the central lobe; they pass in a curvilinear direction towards the fore part of the superior vermiform process, above the peduncles of the tubercula quadrigemina, and add to the thick fasciculus, in which the peduncles of the annular protuberance cross over the latter: the fibres of these plates seem to pass transversely from ridge to ridge. If the preceding method should fail, the lobuli may be removed singly, by means of the handle of the knife; a trial being made, on the removal of the first or second, to effect the raising of the whole lobe, at the requisite level: if the rent be made at a greater depth than that above described, a coarsely fasciculated stratum is exposed, which is inclined inwards, encircling the ciliary body. The removal of both the square lobes in this manner facilitates the complete exposure of the under surface of the cerebellum. In the adjoined drawing the square lobe of the left hemisphere, to its juncture with the superior vermiform process, the first lobule of the upper and superior lobe, and

the anterior half of the second, are represented as broken away: the cerebellum is inclined obliquely towards the right side.

a. The Right Hemisphere.

b. The Left Hemisphere.

c. c. The Superior Vermiform Process.

d. The Purse-like Fissure.

e. The Tubercula Quadrigemina.

f. The Left Peduncle of the Tubercula Quadrigemina, freed from the central lobe, and therefore exposed to its connexion with the nucleus, where the peduncle of the annular protuberance crosses over it.

g. A point, at which a greyish substance of looser texture appears, from between the anterior, and middle peduncles; it is a process of the ciliary body. This substance, which shrinks in alkohol more than the neighbouring parts of the cerebellum, and when exposed to the air dries more quickly, is easily separable from the medulla of the nucleus; in this case, its shrinking had produced a spontaneous separation.

h. A triangular portion of the Crus Cerebri, interposed between the peduncle of the Tubercula Quadrigemina, and that of the Annular Protuberance: there is a groove marking the boundaries of these parts on either side of the crus cerebri meeting its fellow at an angle.

i. The Peduncle of the Annular Protuberance.

k. A part of the upper surface of the Peduncle [*i.*] which is smooth externally, where it forms the floor of

the horizontal fissure; but internally grooved, where it forms a centre, from which fibres diverge on all sides constituting the nucleus. This surface is best seen in a cerebellum previously hardened in alkohol, and afterwards immersed in a weak solution of potass. Vessels either numerous or of large size enter at this point.

l. The medullary substance of the same Peduncle, extending itself to the Lobules of the Upper and Posterior Lobe; with the sloping surface of the laminated stratum, which is continuous with the central plates in the lobules of the square lobe.

m. m. m. Three somewhat rounded ridges, having deep excavations interposed, from which the medullary plates arise, which enter the lobules of the square lobe: the first is the most intricate, the circular fibres of which pass inwards over the peduncles of the annular protuberance; with these are articulated all the anterior lobules of the square lobe, which are connected with the vertical process of the general commissure. These lobules are in part inclined forward; others are vertical or inclined slightly backward.

n. A slighter ridge, upon which the medullary stem of the first lobule of the Upper and Posterior Lobe is placed.

o. o. Delicate ridges corresponding with laminæ.

FIG. II.

represents the surface exposed, by breaking off, in a similar manner, the biventral and slender lobe, half of the almond-like lobe, and that surface of the lobule of the under and posterior lobe, which lies nearest to the slender lobe. The handle of the scalpel is directed under the biventral lobe, over the extremity of the flock, and the peduncle of the annular protuberance, so as to raise the outer margin of the biventral and slender lobes. Then the surface of the under and posterior lobe nearest to the slender lobe is to be broken through to the nucleus, and the rent carried laterally towards the valley, as far as to the middle of the almond-like lobe, where the fissure is to terminate, being directed along its axis to the surface. The surface now exposed is covered with ridges and intermediate depressions, like the former, beneath which likewise a laminated and sloping stratum lies.

In this figure, the biventral and slender lobes are supposed to be entirely removed on the left side, as well as the neighbouring surface of the under and posterior lobe, and the outer half of the almond-like lobe, to the depth of the nucleus.

a. a. The Crura Cerebri.

b. b. The Annular Protuberance.

c. The Medulla Oblongata cut through, and somewhat inclined to the right.

d. The right Hemisphere.

e. The left.

f. The Pyramid.

g. The outer margin of the Square Lobe.

h. The Peduncle of the Annular Protuberance.

i. The Flock.

k. The Almond-like Lobe broken in half.

l. The point upon the under surface of the Peduncle of the Annular Protuberance, from which fibres diverge, and expand into the under portion of the nucleus.

m. A considerable ridge, on which the biventral lobe is articulated; this divides towards the almond-like lobe into two lines, the anterior of which passes to the posterior margin of the stem of the almond-like lobe, the posterior towards the stem of the pyramid.

n. A second ridge, somewhat more marked, with which the slender lobe is articulated; between these ridges, and on either side of them, shallow depressions or channels exist.

o. o. o. The broken stem of the Under and Posterior Lobe, upon which the slight ridges for the laminæ of its anterior surface are seen. Into the divided laminæ, which remain on the side nearest the pyramid, medullary plates may be seen passing from the ridges.

Plate VIII.

Fig. I.

The vertical section of a small lobule, from the circumference of the Cerebellum, seen in its natural size as well as magnified, upon which there are five laminæ. The two undermost laminæ on the right side are split in their axes, and drawn away from the lateral surface of the lobule. The furrow at the centre of the base of each lamina, and the corresponding ridge, are seen.

For this preparation, a thin lobule, or the half of one divided in its axis, may be taken, and cut into strips of the thickness of a quarter or an eighth of an inch. The laminæ may then be raised with a blunt instrument from the base towards the circumference. The fissure will run along the surface of the branch, separating the laminæ from it, and dividing each in its axis. In this way, the entire series of laminæ on one side of a branch may be raised, and unfolded, and each lamina finally divided.

Fig. II.

A portion of the surface of an hemisphere covered with cortex, which is prepared in two ways, to show

the reflection of the medullary plates from the lateral surface of one lamina, over the opposed surface of that adjoining. The portion taken should have laminæ sufficiently broad, and such as rise vertically form a lobule: upon the external surface of one of these laminæ an incision is made parallel to the course or axis of the lamina, one half of which is then pressed towards the neighbouring lamina. The rent passes down the centre of the first lamina, and is reflected up the centre of that adjoining, which it divides, thus cutting out a wedge-like portion.

a. The two laminæ, the adjoining surfaces of which are broken away.

b. The wedge-like portion from the two laminæ everted.

The object is still better attained by separating two laminæ, and removing the cortex from the opposite surfaces, and then making a slight incision upon one of them; if the layer cut through be drawn out with the forceps, the rent, as before, descends the first, and is reflected up the adjoining lamina.

c. c. The furrow between two laminæ opened.

d. d. The limits of the surface, from which the cortex is separated.

e. e. The medulla of two laminæ stript of its cortex.

f. The spot where the exterior medullary plate is removed from the opposed surfaces of the two laminæ.

g. The portion removed.

Fig. III.

The vertical section of a stem with two branches.

a. The stem.

b. c. Its two branches.

b. The upper branch split in its axis; its two portions, when pressed together, leave an angular furrow opposite to the point at which the stem divides.

d. The central medulla of the larger branch continuous with that of the stem: at the angle where this branch and the stem join, the ridge is seen, which corresponds with the furrow above described.

In this preparation it is seen, that the branches unite with the stem in the same manner as the laminæ with the branches. The preparation is best made by selecting the posterior lobules of the square lobe after its separation, then pressing the laminæ off from one surface of a branch, and carrying the rent down that surface, whence it is reflected along the opposite surface of the adjoining branch.

Fig. IV.

The almond-like, the biventral, and slender lobes are broken away from the under surface of the cere-

bellum. The inner extremities of the biventral and slender lobes bordering upon the valley are seen in a vertical section.

a. a. The nucleus of the right hemisphere cut through vertically.

b. c. The under surfaces of the nucleus, from which portions of the biventral and slender lobes have been removed.

b. The ridge for the biventral lobe.

c. The ridge for the slender lobe.

d. One surface of the biventral lobe.

e. The slender lobe; its two outer surfaces with their laminæ are separated from the central medullary plates, which remain upon the ridge, and ascend into the two upper laminæ. The outer surface on the right is reflected, so as to be continuous with the neighbouring surface of a lobule of the under and posterior lobe; that on the left is directly reflected to the biventral lobe. In the interval corresponding with the second reflection is the apex of a trifling lobule, which is likewise split in its axis. The central plates of the biventral lobe are separated from its ridge, which is thrown towards the left.

Fig. V.

The square lobe of the right side broken off from the nucleus, and its under surface represented.

The outer margin, at which its lobules overhang

the horizontal fissure, is here on the left; the inner margin, which should join the superior vermiform process, but is here obliquely divided, is on the right; the anterior margin, which contributes to the semilunar notch, is above; the posterior, which borders on the upper and posterior lobe, is downwards.

The laminated stratum, upon which the square lobe is placed, is here removed. The lobules may be opened in their centre after this, as has been in the present instance effected in nine; above, two lobules, and below one, remain unopened.

Fig. VI.

The internal medullary surface of a portion of the slender lobe torn through in its axis. The two posterior lobes, which have still broader lateral surfaces, would serve as well for this preparation, and the brain should not be too much indurated. From the margin of the medullary surface nearest to the nucleus, a medullary plate is to be raised, after a shallow incision, and then drawn obliquely off with the forceps: a few drops of spirit should be poured upon the part during this process. In this way are exposed the furrows, indicating the axes of the laminæ, the intermediate convex surfaces, the ridges, and the medullary plates passing from the latter into the furrows.

a. a. The internal medullary surface of a portion of the slender lobe, opened in its axis.

b. The cortical substance of that surface of the lobe, which borders on the under and posterior lobe.

c. e. Places, where the medullary, as well as the cortical substance, has been broken through in the separation of the removed portion.

d. Raised lines visible on the rent surface, which are sections of medullary plates passing into the centres of the laminæ.

e. A medullary plate raised in a direction obliquely towards the surface, and from left to right: at its under surface the articulating ridges are seen, which correspond with the opposite furrows. At the point where the partially raised layer joins the lobe, strong medullary plates may be seen passing from its ridges into the furrows.

Fig. VII.

A lobule of the biventral lobe divided in the middle; its medullary internal surface represented.

a. a. The surface delineated, as it appears immediately after its separation; it presents an appearance of grooves, fibres, and laminæ, which is more readily comprehended when seen than from description.

b. b. The last lamina of the superior margin divided.

c. c. A wedge-like portion, composed of half the lamina next on this side adhering by the reflected external medullary plate.

1. 2. 3. 4. 5. 6. 7. Seven strips of medullary plates raised in succession; of which 1. enters the furrow in the lowest lamina; 2. that in the next above, and so on. The medullary stem consists of plates, of which the outer enter the furrow of the lowest lamina, and so on in succession.

d. A surface, from which the central medullary plates are entirely removed, so as to show the furrows of the laminæ; the natural separation continued from the furrow of each along its axis, is shown on the obliquely divided surface: between the internal furrows the convex and parallel surfaces are seen, which correspond with the external furrows.

e. A medullary surface turned back, exhibiting as many ridges, as there are laminæ upon this half of the lobule.

Fig. VIII.

A broad medullary plate, from the under and posterior lobe of the right hemisphere of the cerebellum, to which a part of the circular fibres of the nucleus adheres.

a. a. The marginal laminæ stript of their cortex.

b. b. The portion corresponding to the under and posterior lobe.

c. c. The line at which the fibres of this lobe are placed on the nucleus. These fibres are more delicate, and converge towards the centre of the hemisphere:

upon their lateral surface several ridges are visible, for the articulation of lobules and laminæ.

d. e. The portion belonging to the nucleus.

d. A point, at which the circular fibres of the nucleus are inclined more abruptly inwards: the radiated fibres of the lobe are placed almost perpendicularly upon these, and may easily be raised from them.

e. A point more internal, at which the curved fibres have the appearance of being continuous with the radiated fibres.

f. The margin, at which the stratum of curved fibres was separated from the peduncles of the annular protuberance.

Fig. IX.

A convolution of the cerebrum previously hardened in alkohol, and rent from within outwards.

a. a. The cortical substance.

b. The medullary substance, the radiation of which is towards the circumference.

c. The surface directed towards the nucleus of the cerebrum.

This engraving, though from an indifferent specimen, may give some idea of the structure of the convolutions, which are placed on the nucleus of the cerebrum; they are all of similar fabrick, and form the greater part of the brain. The cerebrum is composed after a similar type to that of the cerebellum; it has a

nucleus, and organs, which encircle it. The convolutions of the brain, like the laminæ of the cerebellum, consist of medullary plates, as these plates again, of fibres, and their exterior surface is covered with a layer of cortical matter; but they are not collected into stems, and they are far larger and stronger than the laminæ of the cerebellum. The medullary plates are least adherent in the centre of the convolutions, but are not so easily separable as the laminæ of the cerebellum, on account of their incurvation. The layers of medulla have a radiated fibrous structure, the feather-like radiation being directed towards the circumference: hence it is easy to raise the fasciculi from the nucleus outwards, but they will not tear transversely. The cortex is easily separable from the medulla; it lies, at the surface of the convolutions, in the same line with their fibres; laterally it seems to be disposed at right angles to them.

Appendix to the Anatomical Observations of Professor Reil on the Cerebellum. Archiven für die Physiologie. Neunterband, p. 129—135.

VII.

The square lobe includes the greater portion of the anterior and upper surface of the cerebellum, is bounded internally by the superior vermiform process, before, by the semilunar fissure, externally by the horizontal fissure, and behind by a deep furrow (interposed between it and the upper and posterior lobe), which extends in a circular direction from one horizontal fissure to the other, and passes through the upper vermiform process before the single commissure. This lobe lies over against the under and posterior, the slender and biventral lobes, and the flock in the horizontal fissure; and its anterior angle is so far advanced as to be placed vertically above the origin of the fifth pair of nerves.

The upper and posterior lobe is bounded on the fore part by the furrow above described, behind by a similar furrow, which separates it from the under and posterior lobe. The two lobes of this name are united by the single commissure in the purse-like fissure, include the posterior portion of the upper surface of the cerebellum, and part of its posterior margin, and externally lie over against the under and posterior lobes in the horizontal fissures.

The under and posterior lobes are separated, before, from the upper and posterior, and behind, from the slender lobes, by deep furrows; are internally broad where they are united by the short commissure [Tab. III. *h.*] and the long and concealed commissure, which in truth consists but of the laminæ of the under surface of the same stem, that furnishes the short and exposed commissure. The external margin of these lobes on either side is narrow and pointed, lying over against the extremity of the upper and posterior in either horizontal fissure. These lobes complete the posterior surface of the cerebellum.

The slender lobes are not constantly separated from the preceding, but always from the biventral lobes, by a furrow, which sinks to the depth of the nucleus: they are united in the valley by the pyramid, and in the horizontal fissures they lie over against the square lobes, and are in contact with the flocks.

The biventral lobes are divided in the middle: each has the form of a wedge, the point of which reaches the valley, and its base the horizontal fissure; they are incurvated somewhat towards the valley, and the furrows between their marginal laminæ run parallel with the medulla oblongata. In the horizontal fissures they are in contact with the flocks, and in the valley the apex of either joins the medullary stem of the pyramid laterally.

The almond-like lobes are depressed towards the valley, are situated between the biventral lobes, the pyramid, the spigot, and nodule, with their rounded

internal extremities in the swallows nests. Their medullary stem is attached to the pyramid, along with that of the nodule and spigot.

In order to shew the connexion of the lobes and lobules of the hemispheres with the general commissure, and the composition of the latter, the opposed surfaces of the different lobes should be stripped of their laminæ; at the bottom of each furrow is thus exposed an angular surface, being part of the laminated stratum which supplies the lobes with ridges of articulation and central medullary plates.

The lobules of the square lobe are separated by uniformly deep furrows every where, but near the vermiform process, on their approach to which several lobules adhere to one stem. This is the cause why a greater number of medullary stems is seen in the section of an hemisphere [Tab. V. Fig. 1.] than in that of the general commissure [Tab. III. Fig. 1].

The nucleus of the general commissure is situated at a deeper level than that of either hemisphere, partly owing to its smaller bulk, partly to the exclusively vertical direction of its branches; hence the cup-like depressions between its lobules, when they are separated. The most capacious of these exist between the stems [Tab. III.] *d. e.* and *e. g.* of which the posterior again is the larger cavity. If at this point the surface be rent from behind forwards, or the pyramid be split from its apex to its base, the round and nerve-like fasciculi [Tab. VI. Fig. 1.] are exposed, which ascend towards the purse-like fissure, and are apparently con-

tinuous with the anterior peduncles. The remaining hollows are of inferior depth: similar depressions exist upon the under surface, the first behind, the second before the pyramid, and the third between the spigot and nodule.

The single commissure, which connects the upper and posterior lobes, is sometimes concealed between the last lamina of the superior vermiform process, and the uppermost in the purse-like fissure; but for the most part it appears as a distinct transverse band upon the surface. The single commissure has an even cortical surface, except laterally, where it is joined above and on the fore part by the last lamina of the square lobe, and below by the first lamina of the under and posterior lobe.

The pyramid is the principal portion of the inferior vermiform process; its medullary stem enlarges laterally, and is connected with all the lobes of the under surface, and with the eminences in the valley. The spigot and nodule have scarcely distinct stems, but join themselves laterally to the stem of the pyramid. If the posterior surface of the pyramid be peeled away, the rent removes at the same time the long commissure; if its anterior surface, the rent removes the neighbouring surface of the spigot. The nodule may be split from its apex to its base, where the portions break off.

The upper and posterior lobes are joined directly by the single commissure; the under and posterior lobes by the short and long commissures; the slender lobes by the long commissure and the pyramid; the

biventral lobes and the almond-like lobes are continued vertically into the stem of the pyramid. The lobules of the upper surface of the hemispheres lie on the same plane nearly with the superior vermiform process; those of the under surface extend greatly beyond the level of the inferior; hence it happens that the inner extremities of the posterior, slender, and biventral lobes, seem as if abruptly cut away.

The stem of the flock divides into two roots, one of which passes round the posterior margin of the swallow's nest to the pyramid, the other transversely across the peduncle of the medulla oblongata to the central depression in the floor of the fourth ventricle; between the two, the outer corner of the lateral portion of the medullary velum joins the stem of the flock.

The anterior medullary velum connects the peduncles of the tubercula quadrigemina, is composed of fibres similarly arranged with those of the peduncles, passes backwards towards the purse-like fissure, and is connected with the stems of the upper and under vermiform processes.

All the lobes and lobules are arranged upon surfaces of the lateral peduncles; even the upper and posterior lobe is placed upon its posterior margin, or it may be said that the peduncle of either side terminates in this lobe; hence the difficulty of reflecting the laminated surface of this lobe, continuously with that of the adjoining lobes; such a rent generally extends into the nucleus.

Experiments to determine the Influence of the Portio Dura of the seventh, and of the Facial Branches of the fifth Pair of Nerves.

THE only unexceptionable evidence respecting the influence of individual nerves in human beings, consists in the record of cases, in which, through accidental violence, or in surgical operations, single nerves have been divided in the living human body. In default of such evidence, the next measure is to collect the results of experiments made on animals: if by this method it be discovered that corresponding nerves in different kinds of animals have uniformly similar functions, it may be presumed that the like nerves in man have offices not materially different. With the view of contributing some materials to serve as data in an argument of this nature, I shall describe the distribution of the portio dura, and of the second and third divisions of the fifth, in the ass, together with the phenomena ensuing on the division of several of their branches, and on that of the frontal nerve.

The portio dura in the ass passes obliquely outwards and downwards after its exit from the cranium, being covered by the parotid gland, to which it adheres, and reaches the root of the condyloid process of the lower jaw, where it is joined by two large branches from the third division of the fifth: previously to this,

the nerve sends a small ascending branch to the ear, a larger, which passes before the ear to the muscles of the forehead, including the orbicularis palpebrarum; and a third, which runs in a contrary direction, to the angle of the jaw, supplying the cutaneous muscle: in most instances, likewise, the nerve receives one or two exceedingly fine filaments from the third division of the fifth, before it is joined by the greater branches which I have mentioned. The common trunk formed by the union of the latter with the portio dura, runs along the cheek, parallel with the jugum, and sends one or two or three branches towards the base of the jaw: these filaments, whether given off singly or together, chiefly supply the cutaneous muscle; but one portion always passes to the muscles of the under lip. The common trunk is now inclined forwards, dips beneath the long muscles of the nostrils and upper lip, crosses over and adheres to the infraorbital nerve, with which several of its fibres are directly continuous; it then terminates in branches, which enter into all the muscles of the nostrils and upper lip.

A frontal nerve from the first division of the fifth, emerges upon the forehead.

The second division of the fifth, after leaving the skull, crosses the sphenomaxillary fissure, in which it gives off four small branches, distributed to the posterior alveoli, the palate, and membrane of the nose; upon the uppermost of these the ganglion is formed, from which the vidian nerve is reflected backwards. The trunk itself scarcely diminished in size, passes

along its bony canal, sending numerous branches to the alveoli, and finally emerges upon the face, where its fibres seem to enter into all the muscles of the upper lip and nostrils, but seem principally to tend towards the margin and internal surface of the lip.

The third division is larger than the second; it sends off at once four branches: the *first* to the pterygoid muscles; a *second* to the masseter and temporal muscles; a *third* to join the portio dura, in the manner above described, a filament from which is reflected to the base of the skull, at the inside of the glenoid cavity, and another to the external ear; and lastly a *fourth*, which gives branches to the soft palate, and then passes outwards, between the two processes of the lower jaw, inclining obliquely downwards, and lying afterwards between the masseter and the bone; in continuation it runs along the under margin of the buccinator muscle, which it supplies, and is finally distributed to the mucous surface of the under lip. The trunk of the third division next divides into the gustatory branch, which sends off the chorda tympani, and then pursues its course by the side of the tongue; and the inferior maxillary nerve, which passes along the canal in the lower jaw supplying the alveoli, and on emerging from it, is distributed to the flesh and integuments of the under lip.

Experiment 1. The infraorbital and inferior maxillary branches of the fifth were divided on either side, where they emerge from their respective canals: the lips did not lose their tone, or customary apposition to

each other and to the teeth; but their sensibility seemed destroyed: when oats were offered it, the animal pressed its lips against the vessel which contained the food, and finally raised the latter with its tongue and teeth: on pinching with the forceps the extremities nearest the lips of the divided nerves, no movement whatever of the lips ensued: on pinching the opposite extremities of the nerves, I observed that the animal struggled violently, as at the moment of dividing the nerves: these latter results uniformly attend the division of the nerves above mentioned, and of that branch of the fifth which joins the portio dura. Some days afterwards, though the animal did not raise its food with its lips, the latter seemed to be moved during mastication by their own muscles.

Experiment 2. The common trunk composed of the portio dura and a branch of the third division of the fifth was divided upon the masseter muscle on either side: the lips immediately fell away from the teeth, and hung flaccid, and the nostrils lost all movement. The sensibility of the lips appeared unimpaired; the animal raised its food as in the former instance. When the extremity nearest the lips of either divided nerve was pinched, the muscles of the lips and nostril on that side were convulsed.

Some days after this, the frontal nerve was divided on one side of the forehead of the same ass; when the neighbouring surface appeared to have lost sensation, but its muscles were not paralysed.

Experiment 3. The portio dura was divided on either

side immediately before its union with the branch of the fifth pair; the muscles of the lips and nostrils seemed as thoroughly paralyzed, as in the preceding experiment.

Experiment 4. That branch of the fifth which joins the portio dura, was divided on either side; at first the under lip appeared to fall away from the teeth, but not to the same degree as in the two former instances; at times the lips were justly closed; and the animal invariably raised with its lips, as readily as before the division of the nerves, the oats, which were at intervals offered it. The asses employed in these experiments, with the exception of the first two, were killed as soon as the effect of the operation had been satisfactorily ascertained, in order to determine by dissection, whether the division of the nerves had been completely effected: in this instance, it was found that on one side, a fine filament of the size of a common thread passed from the branch of the fifth to the portio dura, before the place of the division of the former; no difference had been observed between the action of the muscles on either side of the face.

Experiment 5. A repetition of the preceding; but on one side a larger filament had been left undivided; in this case the under lip did not hang down; no difference had been noticed between the action of the muscles of either side.

Experiment 6. A repetition of the preceding, with exactly the same result as in experiment 5th; and still on one side a filament of the size of a thread

had been left, uniting the fifth with the seventh. Upon the same animal, the infraorbital and submaxillary nerves were divided: the under lip was now observed to hang down a little on one side; but this circumstance seemed fairly attributable to the very extensive division of the muscular fibre on that side. The portio dura was finally divided on one side, where it emerges from the skull; the animal was observed to lose instantly the power of closing the eyelids on that side; to determine which point alone the division of the 7th, near the skull, had been intended.

I infer, from the preceding experiments, that in the ass, the portio dura is a simple nerve of voluntary motion; and that the frontal, infraorbital, and inferior maxillary, are nerves of sensation only, to which office, that branch of the fifth which joins the portio dura probably contributes: and from the preceding anatomical details, that other branches of the third division of the fifth, are voluntary nerves to the pterygoid, the masseter, the temporal, and buccinator muscles.

I was induced to perform the preceding experiments on reading an essay by Mr. Bell *, in which a novel view of the functions of certain nerves is propounded; resting in part upon experiments in great measure similar to those above narrated, but differing materially in their results. As nothing is so preju-

* Philosophical Transactions, Vol. CXI. p. 398—424.

dicial to the interests of science, as the temporary adoption of an unsound theory, I shall hazard a few remarks upon that of Mr. Bell.

Mr. Bell observes that "the nerves of the spine, the tenth, or suboccipital nerve, and the fifth or trigeminus of the system of Willis constitute the original and symmetrical system*," which is equally found "in the leech and worm:" that "these nerves have all double origins; that they have all ganglia on one of their roots; that they go out laterally to certain divisions of the body; that they do not interfere to unite the divisions of the frame; that they are all muscular nerves, ordering the voluntary movements of the frame; that they are all exquisitely sensible; and the source of the common sensibility of the surface of the body; and that when accurately represented on paper, they are seen to pervade every part†."

On the other hand, Mr. Bell observes that the par vagum, the portio dura, the spinal accessory, the phrenic, and the posterior thoracic, are "respiratory nerves;" that is to say, "they connect the internal organs of respiration with the sensibilities of remote parts, and with the respiratory muscles, and are distinguished from those, of which we have been speaking, by many circumstances. They do not arise by double

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Philosophical Transactions, Vol. CXI. p. 404.

bid. p.

roots; they have no ganglions on their origins; they come off from the medulla oblongata and the upper part of the spinal marrow; and from this origin they diverge to those several remote parts of the frame, which are combined in the act of respiration *."

I shall endeavour to show, that the preceding distinction is not founded on correct observation, and that in truth the nerves, which Mr. Bell terms "respiratory," do not differ in any important respect, as a class, from those, with which he contrasts them.

1. The par vagum; this nerve has many roots, and has a ganglion near its origin. When the branches of the par vagum which pass to the larynx are divided, the voluntary movements of that organ are destroyed; the part is no longer competent to the formation of sounds, or to assist in the act of deglutition; while on the other hand, respiration is not impeded. The par vagum is acutely sensible; I exposed its trunk in the neck of an ass, and on pinching it with the forceps, the animal gave violent indications of pain.

2. The portio dura of the seventh is proved, by the experiments which I have detailed, to be a common nerve of voluntary motion: if it be divided, the muscles, which receive branches from it, are completely paralysed.

3. The spinal accessory nerve; of this Mr. Bell

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* Philosophical Transactions, Vol. CXI. p. 405.

observes, that "it controuls the muscles of the neck and shoulder in their office as respiratory muscles, when by lifting the shoulders, they take the load from the chest, and give freedom to the expansion of the thorax. When it is cut across in experiments, the muscles of the shoulder, which were in action as respiratory muscles, cease their co-operation, but remain capable of voluntary actions *."

In human beings, the only muscles of the neck and shoulder, which receive branches from the spinal accessory, are the sterno-cleido-mastoideus and the trapezius.

4. The phrenic nerve is formed of branches of four or five spinal nerves; it generally receives a fine filament or two, from the ninth pair, the par vagum, and the sympathetic.

5. The posterior thoracic nerve is formed of branches of the spinal nerves.

Mr. Bell observes further, that "there are other nerves of the same class which go to the tongue, throat, and windpipe, no less essential to complete the act of respiration. These are the glosso pharyngeal nerve, the lingual or ninth of Willis, and the branches of the par vagum to the superior and inferior larynx †."

Of the latter I have already spoken; the ninth, it is

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* Philosophical Transactions, Vol. CXI. p. 407.

† Ibid. p. 408.

commonly supposed, is the voluntary nerve of the tongue: consistently with which hypothesis I have remarked, that on pinching this nerve with the forceps in an animal recently killed, the muscles of the tongue are convulsed, which does not happen when the gustatory nerve is thus mechanically irritated. In a rabbit, in which I had divided this nerve on either side, the tongue was motionless, so that, when it was drawn out of its natural situation, and left with its extremity between the teeth, the animal did not retract the part within the mouth. This experiment obviously points to other inquiries, which I have not yet pursued to any extent.

Having stated these facts, I leave it to the reader to decide whether they are consistent with, or subversive of, Mr. Bell's theory of " Symmetrical and Respiratory Nerves," and proceed to give an account of his experiments.

These consist in the division of the portio dura on one side of the head in different animals, and of the division of the infraorbital nerves on both sides.

" An ass being thrown, and its nostrils confined for a few seconds, so as to make it pant, and forcibly dilate the nostrils at each inspiration, the portio dura was divided on one side of the head; the motion of the nostril of the same side instantly ceased, while the other nostril continued to expand and contract in unison with the motions of the chest. On the division of the nerve, the animal gave no sign of pain: there was no struggle nor effort made, when it was cut across. The animal

being untied, and corn and hay given to him, he eat without the slightest impediment *."

This experiment is inconclusive, because the nerve was not divided on both sides: had this point been attended to, a different result would probably have ensued.

"An ass being tied and thrown, the superior maxillary branch of the fifth nerve was exposed. Touching this nerve gave acute pain. It was divided, but no change took place in the motion of the nostril: the cartilages continued to expand regularly in time with the other parts, which combine in the act of respiration, *but the side of the lip was observed to hang low, and it was dragged to the other side.* The same branch of the fifth was divided on the opposite side, and the animal let loose. He could no longer pick up his corn: *the power of elevating and projecting the lip, as in gathering food, was lost.* To open the lips, the animal pressed the mouth against the ground, and at length licked the oats from the ground with his tongue. The loss of motion of the lips in eating was so obvious, that it was thought an useless cruelty to cut the other branches of the fifth †."

The first statement, printed in italics, is contrary to my own observation; the second, a theoretical account of the fact that the animal did not elevate and project

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* Philosophical Transactions, Vol. CXI. p. 413.

† Ibid.

its lip. This fact was noticed in my own experiments, but appeared to me from the first equally consistent with the hypothesis, that the lip had merely lost its sensibility, as with Mr. Bell's explanation; in which conjecture I was borne out by what occurs in cases of anæsthesia in human beings: afterwards, I was able to prove the correctness of my supposition, by the result of experiment 3.

From such experiments, however, as the two last detailed, coupled with the facts that on the division of "the branch of the fifth pair, which goes to the forehead, on account of tic douloureux, no paralysis of the muscles of theey ebrow followed; while, in an individual, where an ulcer and abscess, seated anterior to the tube of the ear, affected the superior branch of the respiratory nerve, the eyebrow fell low, and did not follow the other, when the features were animated by discourse or emotion*;" and, again, with the fact, that by the division of "a branch of the nerve, which passes to the angle of the mouth," a coachman was deprived of the power of whistling, Mr. Bell derives the following inferences:

That the nerves of the fifth pair are the "original and symmetrical nerves" of the face, imparting sensibility to it, and exciting its muscles to the prehension of food; and that "the portio dura of the seventh is

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* Philosophical Transactions, Vol. CXI. p. 416. I have in this extract transposed the words of the original.

the respiratory nerve of the face; that the motions of the lips, the nostrils, and the velum palati are governed by its influence, when the muscles of these parts are in associated action with the other organs of respiration *."

These inferences are, on the one hand, applied by Mr. Bell and Mr. Shaw, to explain the phenomena of partial paralysis of the face; and, on the other, to illustrate a principle assumed in Mr. Bell's theory, that organs, the muscles of which are employed in more than one function, are supplied with distinct nerves, to excite each separate mode of muscular action; or, as the author expresses this assumption in regard to the nerves of the face: "In reviewing the comparative anatomy of the nerves of the mouth, we shall find, that in creatures which do not breathe, the mouth having only one function to perform, one nerve is sufficient †."

It remains for the reader to decide, whether Mr. Bell's experiments are satisfactory, and bear out his inferences; whether the latter, coupled with my former

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* Philosophical Transactions, Vol. CXI. p. 414.

† Ibid. p. 402. Perhaps the most destructive mode of putting some of the preceding facts in opposition to Mr. Bell's theory, is the following :—The ass does not appear to breathe through its mouth, yet the portio dura in this animal sends branches to the lips, the division of which, and of which alone, paralyzes the muscles of its lips.

observations on the five "respiratory nerves" of this author, leave his theory tenable; and perhaps finally to determine, whether there exist in the whole of Mr. Bell's essay, after the deduction of his controvertible statements, more than one correct inference. I here allude to Mr. Bell's experimental confirmation of an opinion, which, at the beginning of the eighteenth century, occurred to Dr. Blair* on his minute examination of the proboscis of an elephant, viz. that the infraorbital nerves are nerves of touch.

* Philosophical Transactions, abridged, Vol. V. p. 95.

THE END.

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ANATOMICAL AND PHYSIOLOGICAL COMMENTARIES.

BY HERBERT MAYO,

SURGEON AND LECTURER IN ANATOMY.

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CONTENTS.

ANATOMICAL AND PHYSIOLOGICAL COMMENTARIES.

No. II.

On the Cerebral Nerves, with reference to Sensation and voluntary Motion.

If other evidence were wanting, the distribution of the first and second nerve, and of the portio mollis of the seventh, would sufficiently attest their different and exclusive uses as nerves of the special senses; in like manner, the distribution of the greater part of the third, of the fourth, and of the sixth nerves to voluntary muscles *, which receive filaments from no other

* By voluntary muscles I mean such as during health, and when their use has not been neglected, can be moved at will. At the close of this essay the question is noticed, whether any such muscles habitually act involuntarily.

source, demonstrates that these nerves are voluntary nerves, as well as conducive to muscular sensation. Perhaps it is not unfair to argue analogically from the preceding instances, that the same surface of the brain, or spinal chord, furnishes to each voluntary muscle of the body its voluntary and sentient nerves, if the two are not identical; a circumstance, which I shall presently mention, attending injuries of the portio dura, and of the motor linguæ, corroborates this supposition.

Where several nerves are so distributed to a part as to afford no certain clue to a knowledge of their separate offices, the division of these nerves singly, in living animals, is well calculated to determine the influence, which belongs to each; but this method is inapplicable in various instances, owing to the difficulty both of exposing nerves when small and deeply seated, and of appreciating the changes which possibly ensue, when they have been successfully divided. In this uncertainty some assistance may be derived from noticing the effects of mechanically irritating single nerves in living and in dead animals.

If a nerve, known to be a voluntary nerve, from the paralysis and flaccid state of one or more voluntary muscles, which follows its division in a living animal, be exposed and divided in an animal very recently killed, the muscles, which it supplies, are excited to a single momentary contraction, whenever the extremity of the nerve connected with them is pinched, as with dissecting forceps, care being taken that each successive impression be made on the nerve at a point nearer

to the muscle than the last. If a nerve, known to belong exclusively to sensation, pass by or through a voluntary muscle, no similar effect follows, when it is similarly injured: thus, the muscles of the lips in an ass are convulsed when the portio dura is mechanically irritated, but remain unaffected when the branches of the fifth, which perforate them, are pinched. Hence it may be inferred, that where the muscles of a part are voluntary, those nerves convey to it the influence of the will, on the injury of which, in the way described, muscular action ensues.

If the nerves distributed to the heart, to the stomach, and to the intestines, the fibre of which is beyond all doubt an involuntary muscle, be pinched, no immediate change follows in the action of these parts. If then it should be found that one or two other irritable parts, which, in human beings in general, the will cannot directly excite to action, be convulsively contracted, when nerves attached to them and disconnected with the brain be pinched, would it be admissible to doubt, whether possibly these movements are not instinctive, and thus to place them on a par with the infant's respiration? leaving the question still open whether instinct imply or not the agency of the will.

If a nerve, known to belong to the sense of touch, by the immediate insensibility of the surface, which it supplies, incurred on its division, be divided, and the portion next the brain pinched with the forceps, in a living animal, indications of violent pain are given. Such an injury of the facial branches of the fifth in a

living ass is attended with the result mentioned, which however does not ensue, when the portio dura is pinched in that animal. I had conjectured that a general criterion to distinguish nerves of cutaneous or similar sensation might be derived from the preceding remark; but I have since found, that in animals less patient than the ass, as the cat and dog, the irritation of the portio dura produces an expression of pain distinct, though not as violent, as that resulting from an injury of the fifth: this effect, I suppose, depends upon the connexion of the portio dura with muscular sensation. Perhaps, as there is an evident difference in the intensity of pain occurring on the irritation of a cutaneous and of a muscular nerve, it may still be interesting to ascertain in what degree different nerves are sensible, as a means of gaining collateral evidence, however slight, of their uses.

The first problem of any difficulty furnished by the cerebral nerves is to determine the cause of the movements of the iris. To assist towards its solution thirty pigeons were employed in experiments, of which the following are the results:

1. When the optic nerves are divided in the cranial cavity of a living pigeon, the pupils become fully dilated, and do not contract on the admission of intense light.

2. When the third nerves are divided in the cranial cavity of a living pigeon, the same result ensues: in both these cases the surface of the eyeball retains its feeling.

3. When the fifth nerve has been divided on one side in the cranial cavity of a living pigeon, the iris on that side contracts as usual on the admission of light, but the surface of the eyeball appears to have lost its feeling.

4. When the optic nerves are pinched in the cranial cavity of a living pigeon, or immediately after its decapitation, the pupils are contracted for an instant on each injury of the nerves.

5. When the third nerves are similarly irritated in the living or dead bird, a like result ensues.

6. When the fifth nerve is similarly irritated in the dead bird, no affection of the pupil is observed.

7. When the optic nerves have been divided within the cranial cavity of a pigeon immediately after its decapitation, if the portion of the nerves attached to the eyes be pinched, no contraction of the pupil ensues: if the portion adhering to the brain be pinched, a like contraction of the pupil ensues, as if the optic nerves had not been divided.

8. The previous division of the fifth nerves in the preceding experiment produces no difference in the result.

9. When the third nerves have been divided in the cranial cavity of the living or dead bird, no change in the pupil ensues on irritating the entire or divided optic nerves.

It may be inferred from the preceding induction, that diminution of the pupil results from the action, and dilatation of the pupil from relaxation of the iris;

that the nerve which immediately controls the action of the iris is the third nerve; that in the habitual variations of the pupil, an impression is conveyed to the brain along the optic nerve, which is followed by an affection of the third pair, causing the pupil to contract or to dilate; finally, that the common feeling of the eye is derived from the fifth nerve.

Among the preceding experiments, those, which were performed upon the separated head, succeeded only, when the nerves were very quickly exposed, and the removal of the bone and upper surface of the brain executed separately, and without violence.

It is a curious circumstance, and one not generally known, that the pupil is contracted during sleep to a smaller circle than when submitted to the same light at other times. This remark I made and verified in several instances some years ago. My friend, Mr. Cæsar Hawkins, to whose assistance I am much indebted in the performance of the preceding experiments, recently, at my request, repeated this observation; and communicated to me an additional fact, that the pupil, thus habitually diminished during sleep, is capable of still further contraction on the admission of intense light. In most cases, when the upper eyelid of a person in sound sleep is raised, the eye is found directed straight forwards: but in some instances, the eye is directed upward and outward, I suppose, to avoid the light. At the moment of waking, the pupil broadly dilates, and then, after two or three irregular contractions, or at once, resumes its usual tone.

The peculiarity, which consists in the derivation of the three muscular nerves of the eye from distinct parts of the brain, is not easily explained. Four muscles retract the eyeball, and in various combination may direct its axis upward, downward, outward, or inward: two muscles carry the eye forward, and neutralize the further effect each of the other: but one nerve, the third, supplies three of the first set (not to mention the levator palpebræ), and one of the second. Again, the sixth supplies the abductor; but the action of that muscle, in human vision, has nothing peculiar: it may have, doubtless, in animals, both eyes of which cannot be directed at once to objects placed in a certain relation to the head; and it is possible that, for a similar reason, the obliquus superior oculi, which directs the axis of the eye downward and outward, may be supplied exclusively by the fourth.

The influence of the remaining parts of the fifth I have ascertained by experiments made upon asses, or have inferred from the exclusiveness of their distribution to particular parts. The course of the fifth in human beings corresponds so accurately with that in the ass, that I venture to suppose the use of each part of the nerve the same in both instances. The fifth nerve supplies the skin upon the forehead, upon the cheek, and upon the chin, the mucous membrane of the nose and fauces, and the tongue and salivary glands. In the last paper of the preceding number I mentioned that the division of the supraorbital, infraorbital, and inferior maxillary nerves, at the points, where they

emerge from their canals upon the face, produces loss of sensation, and of that alone, in the corresponding parts of the face. I have since, after the division of the fourth branch, which emerges on the face, namely, that which joins the portio dura, ascertained that this branch likewise is a nerve of sensation, inasmuch as the cheek loses sensation upon its division. I mentioned in addition, that I concluded that other branches of the fifth nerve, from their distribution to the pterygoïd, masseter, temporal, and buccinator muscles, are voluntary nerves. This conclusion involved a trifling error: the pterygoïd, masseter, and temporal muscles are indeed exclusively supplied by the fifth, and, therefore, without doubt the branches so distributed are voluntary nerves; but the buccinator receives branches from the portio dura as well, and I have found, subsequently, that pinching the branch of the fifth, which perforates that muscle, produces no action in it. I should remark, on the other hand, that the fifth exclusively supplies a fifth muscle, the circumflexus palati; whence it may be inferred that the fifth is the voluntary nerve of that muscle as well as of the four great muscles of mastication.

Now, it is well known to anatomists, that the fifth nerve at its origin consists of two portions; a larger part, which alone enters the Gasserian ganglion; and another smaller, rising from the annular protuberance before the former, which subsequently does not enter but passes below the ganglion to join itself with the third division of the fifth, and escape with it through

the foramen ovale. Towards the close of last summer I endeavoured to trace the final distribution of this small portion in the ass, and succeeded in making out that it furnishes those branches, which are distributed exclusively to muscles: this dissection I have repeated four times, and in an adjoined drawing have represented the fact as existing in the ass. I have since ascertained that in the human body precisely the same distribution exists. But the remaining branches of the fifth are proved to be nerves of sensation. Thus it appears that the fifth nerve consists of two portions, one of which has no ganglion, and is a nerve of voluntary motion (and probably of muscular sensation), and another, which passes through a ganglion, and furnishes branches, which are exclusively nerves of the special senses. Soemmering, in his very excellent treatise on anatomy, which I believe is universally received as the best extant, compares the fifth pair of nerves with the spinal nerves*: by this analogy I was led to conjecture that the double roots of the spinal nerves have

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* Minor nervi (quinti) pars eandem fere latitudinem servat, et exceptis nonnullis exterioribus fibris, plexum intrantibus, majorem portionem descendendo obliquè præterit, neque ei fibras addit (*eum fere in modum, quo prior radix nervorum spinæ medullæ ganglion non intrat*), fibras tamen proprias multis modis inter se invicem commiscet.
S. R. Soemmering de corporis humani fabricâ (Trajecti ad Mænum, 1798.) Vol. IV. p. 214.

functions corresponding with those of the fifth, and that the large posterior portion of each spinal nerve, with its ganglion, belongs to cutaneous sensation, and the anterior branch to voluntary motion. When I was engaged in experiments to determine the fact, M. Majendie's were published, which establish the justness of my conjecture.

In the preceding number I have mentioned that the division of the portio dura of the seventh nerve paralyzes the muscles of the face. Now the buccinator muscle is intermediate between the cutaneous muscles of the lips and nostrils, and the powerful muscles moving the jaw; and it is somewhat difficult to determine, after the division of the portio dura, whether the muscle in question be paralyzed or not: but the question may be decided by pinching in succession on the dead ass that branch of the fifth which perforates the buccinator, and then the trunk of the portio dura. While the former experiment is unattended with any effect, the latter produces a distinct spasm of the buccinator, as well as of the other muscles about the lips and nostrils. If the portio dura be pinched with the forceps in a living ass, no expression of pain follows; if in the cat, the expression of pain is distinct.

The tongue is supplied on either side with three nerves; the gustatory, the ninth, and the glosso-pharyngeal nerve.

On dividing the gustatory nerve on either side, in a rabbit, the sensibility of the surface of the tongue appeared to be lost; but the muscles of the tongue

did not appear to be paralyzed. On pinching the gustatory nerves in several animals, immediately after their death, no spasm whatever occurred in the muscles of the tongue. On pinching the same nerves in living rabbits, pain was evinced.

In the preceding number, I mentioned that the tongue of a rabbit appeared paralyzed by the division of the ninth pair of nerves. I have since made other experiments, with a similar result. I divided the ninth nerve on one side of the tongue in a dog: the animal did not seem much incommoded, but lapped up milk readily. I then divided the nerve on the opposite side: the animal appeared distressed, and did not again lap up the milk offered to it, though it smelt to it; and finally, when mustard was smeared upon its nostrils, it made no use of its tongue to remove it, though evidently suffering from it. On exposing the ninth nerve, after its division, in an animal recently killed, and pinching the part attached to the tongue, the muscles of the tongue are convulsed. When the ninth nerve is pinched, in a living dog or cat, an expression of pain follows.

I am inclined to suppose, on coupling the last-narrated fact with what has been said respecting the use of the other portions of the fifth, that the gustatory nerve is not a nerve of taste alone, but of touch likewise, as far as the surface of the tongue possesses this mode of sensibility; and entertain no doubt that the ninth nerve is rightly called the motor linguæ.

When the glosso-pharyngeal nerve is pinched in

an ass recently killed, a distinct, convulsive action ensues, apparently including and limited to the stylo-pharyngeus muscle and the muscular fibres about the upper part of the pharynx. Thus the glosso-pharyngeal is in part, probably, a nerve of voluntary motion; and it may be inferred that it is a nerve of sensation, though not of taste, from its distribution to the surface at the root of the tongue.

I am enabled, through the politeness of Dr. Macmichael, to substantiate the preceding conclusions respecting the use of the nerves of the tongue, by the detail of some of the particulars of a case occurring under his care in the Middlesex Hospital, which I have recently had an opportunity of witnessing.

A young man, twenty-six years of age, of singularly dissolute habits, was seized with paralysis of the left side of the face, on the 13th of October, 1822: in little more than a fortnight he became deaf of the left ear; and about the same time lost, but not suddenly, sensation in the left side of the face. When first seized, he remarked, that he could not close the left eyelids, unless he at the same time closed the right: subsequently he has lost the power of raising the left eyelid, and of moving the left eyeball, which is not sensible when touched; the pupil does not change, when a strong light is presented to the eye: the eye is now much inflamed, and the cornea superficially ulcerated; but before this occurred, which was towards the middle of April, the sight of the left eye became dim; at present he can only faintly distinguish with it the

brightest light; finally, he has lost the sense of smelling in the right nostril.

The cause of these symptoms may or may not be disease of the cranial bones, or of the dura mater, affecting several of the cerebral nerves at their exit through the cranium; but, certainly, the olfactory nerve, on the left side, has lost its function; and that of the optic, on the same side, seems impaired. The third, the fourth, and sixth nerves, again, are distinctly paralyzed, inasmuch as the eye is immoveable, and the eyelid cannot be raised. The portio dura is paralyzed; for the mouth is drawn towards the opposite side, and the features are immoveable on the left side, and the eyelids cannot be pressed together. The muscular branches of the fifth are likewise paralyzed; for if this person place a crust of bread between his teeth, and bite it forcibly, the masseter on the right side becomes hard, but that on the left remains flaccid. Again, the branches of the fifth, which supply the skin of the face, have lost their functions; since the surfaces, which these supply, are insensible: but the ear, the skin over the parotid, and a narrow surface extending to the upper lip, in the line of the facial artery, being parts supplied by the second cervical nerve, as well as the back and upper part of the head, are not so; and it is curious to observe, that sensation on the fore part of the face extends a little beyond the median plane upon the left side. Further, the mucous surfaces of the eye, of the left nostril, and of the gums on the left side, are insensible to touch:

and the tongue, on the left side, when its surface alone is irritated, is insensible to touch as well as to taste.

Thus there exists complete evidence, that the function of the fifth nerve is in this case suspended: but if the patient be directed, when his mouth is open, to raise the tip of the tongue to the roof of the mouth, the frænum linguæ remains in the median plane of the body: it may thence be inferred, that the ninth nerve is unaffected; and therefore, that the loss of sensation of both kinds, on its surface, results from an affection of the fifth. Yet, when the substance of the tongue on the left side is pinched, a dull sensation of pain arises there. Is it not probable, that this is a muscular sensation, conveyed along the ninth nerve, consistently with what I have remarked respecting its injury in living animals? But I have adduced this case, principally, to illustrate the function of those branches of the glosso-pharyngeal nerve, which are distributed to the papillæ conicæ and the surface near the root of the tongue. In this individual, the surface at the root of the tongue upon the left side is indeed insensible to touch or taste: sugar placed upon either side is not tasted; but Cayenne pepper placed on either produces, after a time, a sensation of heat, though no perception of its peculiar savour: a probe applied to either side, again produces the feeling of nausea, and an effort of retching. May it not be presumed, that these phenomena result from the exclusive agency of the glosso-pharyngeal nerves?

In this person, the paralyzed side of the face is

slightly œdematous: when his countenance became suffused on touching the root of the tongue with a probe, the suffusion was equal on either side, if not rather greater on the left.

The spinal accessory nerve is extremely singular in its circuitous course, and in its origin, from the side of the spinal chord, behind the ligamenta denticulata: when this division of the eighth nerve is irritated in a living cat or dog, the animal expresses considerable pain, and the muscles which the nerve supplies are convulsed, when the experiment is repeated, after the division of the nerve, on the part adhering to them.

The nervus vagus, from the obvious distribution of its branches to the membrane of the larynx, and its copious ramification on the œsophagus, may be supposed to belong, in part, to sensation. Asses, cats, and dogs, almost invariably express great pain when this nerve, yet entire, is pinched with the forceps; and after its division equal suffering appears to result from pinching the part connected with the brain. M. Majendie's experiments have proved that the nervus vagus furnishes voluntary branches to the muscles of the larynx. If the nerve, yet entire, be pinched with the forceps, in an animal alive or recently killed, or if, after division, its lower part be thus irritated, the œsophagus is convulsively shortened at each repetition of the injury. It may be remarked, that pinching a nerve virtually destroys its connexion with the brain; and thus in the present instance, after

the texture of the nervus vagus has been bruised, to produce sensation a point nearer the brain than that last-injured must be irritated; to produce a spasm in the œsophagus, again, a point more remote from it. No apparent movement in the stomach attends this spasm of the œsophagus.

The sympathetic nerves are formed of branches from the sentient part of the fifth, and from the sixth nerves, and are continually reinforced by branches of the spinal nerves, derived, as Scarpa has ascertained, equally from their anterior and posterior roots. Scarpa has further determined, that ganglia are but fine plexuses, and that no nervous filaments arise or terminate in the gray matter, which is contained in these substances, intended, perhaps, for the security alone of their fine organization. Hence it follows, that the sympathetic nerves, in human beings, can only be regarded as branches of the cerebral and spinal nerves, destined for particular uses; one of which is illustrated by the cessation or interruption of the heart's action, which occurs in a recently decapitated animal, when the spinal chord is crushed. No doubt, in this case, the impression is transmitted from the spinal chord to the heart, through the sympathetic nerves. These nerves, on the other hand, have nothing to do with voluntary motion; but it is probable that they are concerned in sensation, though no expression of pain follows their mechanical injury in the neck or abdomen of the ass, the cat, or the dog.

It may not be out of place to subjoin a few remarks upon the various ways, in which nerves contribute to the action of different irritable parts.

The leading distinction in irritable parts is, that some, on their removal from the body, continue for a period alternately to contract and dilate; while others, with the exception of the mere quivering of the flesh, remain passive, and require the application of a mechanical or chemical stimulus to their substance, or to the nerve connected with them, in order that a single brief contraction may ensue. In a paper in the former number of this work, I mentioned various facts, which tend to prove that one of the parts of the first class, namely the heart, contains within itself its principle of action, and undergoes spontaneous and alternate contractions and dilhtations, as a result of its structure.

Of the second class of parts, some, as the muscles of the trunk, of the limbs, and the like, are distinctly influenced by the will; in others, again, as the muscles of the chest, and of the face in the expression of emotion, the influence of the will is not consciously employed, under ordinary circumstances, to produce their action; and a question arises, whether this or some other principle stimulate the muscles on these occasions. Much may be advanced on either side. On the one hand, it is clear that an influence, independent of the will, occasionally throws voluntary muscles into action, as appears in tetanus and other spasmodic disorders; and is shown remarkably in the

physiological experiment of irritating the skin on the lower extremities, after the division of the spinal chord in the back, when the occurrence of action limited to the muscles of the inferior extremities, evinces that a connection exists, independently of the will, between sentient surfaces and the action of voluntary muscles. I have varied this experiment by dividing the spinal chord at once in the neck and in the back, upon which three unconnected nervous centres exist; and the division of the skin in either part (and especially at the soles of the feet, in the two hinder portions) produces a convulsive action of the muscles in that part alone. The same influence may, then, possibly regulate the unconscious actions, to which these remarks relate. On the other hand, it may be urged, that in many actions purely voluntary, which have become habitual, it is difficult to trace the influence of the will; that the actions in question are now habitual, and began as instinctive but voluntary actions; and that, in confirmation of this view, the muscles of the trunk and limbs occasionally act as muscles of expression; and again, that the action of the diaphragm in breathing, and of the muscles of the face in expression, may be refrained from by a resolute effort of attention, or produced by a conscious exertion of the will; finally, that the existence of but one nerve for the actions of each of these muscles, (which are sometimes at least, and can at any time be influenced by the will), is a little, though very little, in favour of their being always excited to their habitual action by this stimulus;

and that the physiological experiment of making separate nervous centres, by division of the spinal marrow, admits of explanation on supposing the principle of volition to continue for a short period extended to the portions separated from the brain; a conjecture consistent with, perhaps, but far from established by the very curious fact, that the convulsive movement of the leg of an animal thus circumstanced, when the sole of its foot is irritated, is accurately the gesture which the animal employs, when, in undisputed possession of sensation, it retracts its limb from a similar aggression, and not to appearance, at least, a mere convulsive throe.

These reflections, on either part plausible, leave the question undecided, whether any muscular actions exist, during health, directly produced by an impression derived along the nerves, which is not a conscious or unobserved exercise of the will; but, setting that question aside, I think it may fairly be inferred, from all the facts above narrated, that the third, fourth, sixth, seventh, and ninth nerves, together with a portion of the fifth, not included in its ganglion, are nerves in every respect corresponding with those formed by the anterior roots of the spinal nerves; and that they have the same relation to the first and second nerves, to the auditory nerves, and to the portion of the fifth included in either Gasserian ganglion, which the anterior roots of the spinal nerves have to the fasciculi rising on the back part of the spinal chord. It is not easy to arrange the nerves of

the eighth pair in the same system: but, on the whole, these seem to partake of the nature of both kinds of nerves indicated above. The nervus vagus has a ganglion, and is distinctly a nerve of sensation and voluntary motion. The glosso-pharyngeal nerve has a ganglion, and is again, it would appear, a nerve of sensation, and at least of instinctive motion. Finally, the spinal accessory may, possibly, involve both these properties, though it has no ganglion, with which I am acquainted. It is true that this statement does not satisfactorily account for the anatomical peculiarities of these nerves; and, doubtless, much remains to be discovered respecting their influence, even on sensation and muscular motion.

Explanation of part of the Fifteenth Plate.

FIG. I.

Represents the fifth nerve of an ass, removed from the cranium: it is reversed, and the investing membrane dissected off.

1. The larger portion of the fifth nerve.
2. The smaller portion.
3. The Gasserian ganglion, which the former enters, while the latter passes below it.
4. The first, or ophthalmic division of the fifth.
5. The second, or superior maxillary division.
6. The gustatory, and inferior maxillary branches,

which, with the portion 2, and the branch 7 distributed through the buccinator to the mucous surface of the fauces, constitute the third division of the fifth.

8, 9, 10. Distribution of the smaller portion 2 into three branches, to the temporal and masseter, to the circumflexus palati, and to the two pterygoïd muscles.

A few fine filaments, of which one alone is here exposed, and represented larger than it should have been, are reciprocally interchanged between the muscular portion of the fifth, and the sentient portion beyond the ganglion.

All parts of the fifth nerve, in the ass, are more or less reticular, in the arrangement of their fibres, near their origin, and for the greater part of their course. Towards their final distribution the fibres are distinct, and rarely interlace with one another.

In justice to M. Fleurens, I should mention that my experiments respecting the movements of the iris were suggested by reading the account (contained in M. Majendie's Journal, Vol. II. Number 4.) of his very interesting researches; and, in justice to myself, that the statements of M. Fleurens, at all relative to the iris, are the following alone: that, on pricking the tubercles or optic nerves, the pupils contract; that the iris preserves its mobility after the removal of the *lobe cerebral* of the opposite side, and again after that of the tubercles; and is only paralyzed after the profound extirpation of the tubercles or section of the optic nerve.

On the Structure of Horn, Hoof, and Cuticle.

THE horn of the rhinoceros is described by Dr. Macartney as "made up of a number of fibres resembling strong hairs consolidated together, and rendered smooth upon the surface, except around the base, where the external fibres being broken off present the appearance of a brush *;" but it is not I believe generally supposed that the horn of the common ox is formed in a very similar manner. My friend, Mr. Bremner, communicated this observation to me, which he had ascertained by various methods.

If a longitudinal section be made of an adult horn, it is found to be solid near its point, but afterwards to inclose a conical cavity, which is widest at the base of the horn. From the closed extremity of this cavity the substance of the horn becomes gradually though not uniformly thinner, till, at the base, it blends insensibly with the cuticle. Of the substances contained in this cavity, the external is a delicate membrane, which varies in colour with the different shades of the horn, and clothes a tough prolongation of the cutis vera; the latter is supported on a central bony process.

* Rees's Cyclopædia. Article *Horn*.

On examining the cut surfaces of the horn (of which a variegated specimen should have been selected), the middle of the solid part has the appearance of being composed of fibres, extending nearly vertically from the tip of the bony process, or rather of the membrane covering it, to the tip of the horn; the lateral part again appears to be composed of fibres arising every where from the lateral surface of the secreting membrane, and running forwards at a very acute angle. Every fibre does not indeed appear to be throughout of the same colour, so that the general clouding of the horn does not prove the structure to be what is here described; but, on observing the surfaces resulting from many sections, it is difficult not to adopt this supposition.

Further, it is easy, where some violence has been used in rending away portions of fresh horn imperfectly separated by the saw, to raise long fibrils in directions consistent with the preceding account: but what is most to the purpose is, that if the horn be steeped in liquor potassæ for twenty-four hours, and the outer surface, which has become gelatinous, be scraped away, the next part, being only softened by the alkaline solution, peels readily into fibres, which have the direction above described.

The hoofs of animals are described as fibrous; but I have found their structure to vary materially from the simply fibrous structure of horn.

The several parts of the hoof, in the horse and ass, viz. the frog, the sole, the crust, are all formed alike,

though they differ in solidity. The frog and the sole seem composed of blackish fibres nearly vertical to the vascular surface from which they grow; but the crust, the firmest part of all, seems to be composed of alternate white and black fibres, which rise from the coronary ligament, and descend at an acute angle to enclose the former parts, cohering with the lateral and vascular surface of the foot by means of peculiar processes termed elastic laminæ.

If a section be made through an hoof, as in fig. 3, [plate XV. the foot represented is that of an ass's foal] the dark colour and hard consistence of the different parts is found to begin abruptly at a well defined line; above this a narrow whitish layer is found, bounded by a fine black line, the former about 1-10th of an inch in depth. If the surface of this vertical section be minutely examined, especially with a magnifying glass, it may be seen that the cutaneous surface terminates, or that the horny material begins, at the thin black line I have described. This line again is continually interrupted: long and delicate vascular processes pass through the interruptions into the stratum of softer white matter, the texture of which resembles the opaque substance in a feather: if a transverse slice be taken of this white substance, it is seen to be perforated by innumerable foramina, which transmit vascular processes from the cutis vera. These vascular processes are continued downward, and pass into the firm substance of the crust, and into that of the sole and frog, reaching apparently half the depth at least of these several sub-

stances, and I am inclined to think very nearly to their under surface. On making an horizontal section of the crust, it is seen that the only white matter in it is a thin cylinder, which immediately surrounds each vascular process; thus the substance of hoof is rather a tubular than a fibrous mass.

The elastic laminæ are plates of horny matter, which grow from the under part of the coronary ligament, being continuous with the internal surface of the crust. Each elastic lamina is received between, and, in the recent state, adheres to two vascular laminæ, which are processes from the cutis vera covering the foot laterally; the elastic laminæ are carried down with the growth of the crust; the vascular laminæ at their termination are apparently prolonged for a short space in slender villi, and secrete a horny material, which fills up their interstices, so that eventually a solid layer is formed connecting the extremity of the crust to the horny sole: the sides of the elastic laminæ are finely fluted.

The human cuticle, except in the palms of the hands, and soles of the feet, is apparently membraniform: the cuticle of the elephant even has a similar appearance; yet the structure, which this substance assumes, where it occurs of greater thickness, brings it rather to the nature of horn and hoof, with which it imperceptibly blends. The cuticle of the gizzard of an ostrich resembles the former. The drawing Fig. 2. [Plate XV.] is from a specimen in my collection, in which the cuticle is distinctly formed of fibres easily

separable from each other, and rising vertically from the secreting surface. Thickened cuticle, from the palm of the hand, hardened in alum and weak spirit, I have found tear in a manner not inconsistent with the supposition that its structure is similar; and in the magnificent treasure of the Hunterian museum Mr. Clift recently pointed out to me specimens of exceedingly thick human cuticle, where the appearance more strikingly corresponds with that in the ostrich's gizzard.

As instances of the formation of cuticle in a manner similar to that of hoof, I may mention that a soft substance *5* (Fig. 3. Plate XV.), continuous at the back part with the frog, descends around the crust of the horse's hoof for the purpose of protecting its outer surface when newly formed: now this substance blends with the cuticle, is very similar in appearance to the cuticle, yet, for some extent, distinctly receives vascular processes like the hoof itself. In the Hunterian museum again, there are specimens of the cuticle of the porpesse, and of the narwhal, the structure of which, at first apparently fibrous, on minute inspection clearly contains vascular processes like those existing in the horse's hoof. In the thick human cuticle in the Hunterian museum there is an outer layer less distinctly fibrous; and in the skin of the porpesse and narwhal there is an outer layer seemingly membraniform. It is to be presumed that this alteration in the texture of the part is a spontaneous change favoured by the action of pressure and of the media, with which the part is in contact antecedently to its separation.

The human nail resembles in appearance a thin slice of horn, and in a similar way tears more readily transversely than longitudinally; yet it is probable, though I cannot say that I have seen any thing like this, that it is composed of longitudinal fibres: in other points nail resembles hoof very closely. Its internal surface has elastic laminæ, which are received between vascular laminæ of the skin; and if a longitudinal section be made of the end of a finger, it may be seen that the nail has early acquired its full thickness, apparently where its colour changes; and, again, that its tender substance, when newly formed, is protected by a distinct cuticular growth secreted from that fold of skin which overlaps its root: where this cuticular growth is not artificially removed, it rises with the nail, and sometimes may be peeled from its convex surface in as many as three distinct layers.

Fig. II. Plate XV.

Represents a section of the gizzard of an ostrich.

1. Muscular and tendinous substance.

2. Layer of substance strictly analogous to the cutis vera of the integuments, or more loosely to the tunica nervea and villous coat of the human stomach taken jointly.

3. Layer of cuticle raised from the last, consisting of fibres vertical to its surface.

Fig. III.

Section of an hoof, taken from an ass's foal.

1. The crust, seemingly consisting of white and black fibres, passing downwards at an acute angle with the coronary ligament 7.

2. 2. The sole and frog, seemingly composed of black fibres, passing downwards not exactly at a right angle with the secreting surface.

In both the preceding parts vascular processes are found passing downwards in the same direction with, and between the seeming fibres.

3. A layer of horny substance, of closer grain and lighter colour, and seemingly less fibrous than the preceding parts: it is a prolongation of the elastic laminæ, one of which is represented at 4.

5. Layer of cuticular substance, overlapping the crust, and continuous at the back part of the hoof with the frog.

6. 6. The narrow, soft, and white layer, found equally between the solid parts of the crust, of the sole, and of the frog, and the surface of the cutis vera, or its prolongation, on which these substances rest.

7. The coronary ligament.

Fig. IV.

A magnified section of the narrow white layer, marked 5 in Fig. III., made in the direction of the vascular processes which perforate it.

a. The cut extremities of the vascular processes where they enter the solid crust.

b. The abrupt commencement of the black substance of the crust.

Fig. V.

A magnified transverse section of the white layer interposed between the crust and the coronary ligament; it is seen to be perforated by numerous foramina of different sizes, which are sections of the cylindrical canals containing the vascular processes.

Fig. VI.

A highly magnified and somewhat oblique section of the crust. The black ground is the uniform black matter of the crust. The white oval rings are oblique sections of the circular cylinders of white matter, which contain the vascular processes.

It is difficult to determine the origin of this hard

black substance in the crust; for the vascular processes are every where in that substance contained in white horny substance, as the present figure represents. The black matter begins at once abruptly, and, at the same line, the solid texture of the hoof seems completed, the white substance surrounding the vascular processes being now seemingly firmer than above.

A rete mucosum exists every where along the surface, from which the vascular processes arise, but is wanting at the upper margin of the elastic laminæ. The drawings illustrative of the structure of hoof, with the exception of Fig. III. and VII., are taken from the horse.

Fig. VII.

A portion removed by sections nearly vertical from the fore part of the crust in the hoof of an ass's foal. Of this portion the lower part again has been removed by a very oblique section, so as to expose in two views the elastic laminæ. Above, the side of one elastic lamina is seen; below, the obliquely divided edges of several are seen; and lower down, where these terminate in solid horn, corresponding with the portion 3, in Fig. III., an oblique section still shows a faint appearance of the original disposition in plates nearly parallel.

Fig. VIII.

A magnified transverse section of the elastic laminæ in the recent state. They are continuous with the inner surface of the crust, which in the drawing is left unshaded. Their lateral surfaces are delicately fluted. Between each pair a very soft and adherent vascular process intervenes, continuous above with the coronary ligament, and laterally with the cutaneous surface covering the coffin bone, to which surface, in the recent state, the internal extremity of each elastic lamina is adherent. When putrefaction commences, the hoof is separable from the cutis vera; the vascular laminæ remain with the latter; the elastic laminæ separate as part of the former.

Where the elastic laminæ terminate in the substance 3, Fig. III, the vascular laminæ appear to break into fine processes, so that the structure of this part, though finer and closer, is yet similar in essential points to that of the crust.

I have added, in figures IX, X, and XI, drawings of parts of a similar class with the preceding, the structure of which is known.

Fig. IX.

Represents a nearly vertical section of the bulb of the whisker of a lioness: in it are shown, 1st. The firm

and almost cartilaginous oval capsule, in which the root of the hair is inclosed, which is perforated above for the escape of the shaft of the hair, and below for the entrance of blood-vessels with a branch of the fifth nerve. 2ndly, The spongy and somewhat vascular substance, which intervenes between the capsule and the hair, and has a remarkable circular canal near its middle, and an inner surface continuous with the cuticle; and, 3dly, The hair itself, above solid, but its interior of softer matter than its crust; below, conically excavated, and containing a highly vascular conical pulp.

Fig. X.

Represents an oblique section of the bulb of a porcupine's quill.

Fig. XI.

Represents a transverse section of another. The thick exterior crust is continued inwards in slender septa, which tend towards the axis of the quill, and intervene between the masses of soft white opaque material contained within. In the hollow extremity of the quill, a nearly spherical and highly vascular pulp is contained, to which a branch of a nerve may be distinctly traced. From this pulp vascular processes are derived, which extend in the lines of the septa. The crust is soft at first, and appears wholly formed from

the lower margin of the pulp. A membrane continuous with the cuticle, and apparently not vascular, is every where in contact with the quill, where contained in its oblique channel through the skin. This inner membrane terminates at once abruptly at the margin of the crust of the quill: immediately without it a highly vascular membrane exists, which is continuous with the margin of the pulp below, and with the surface of the cutis vera above.

In Fig. X. a black bristle is represented as introduced between the quill and the membrane in contact with it, and a white bristle between the latter and the external vascular membrane.

On Local Action.*

It is certain that many parts in the human body occasionally receive an unusually large supply of blood. Mr. Cruickshank mentions, that if the female rabbit, when disposed to admit the male, be killed and examined, the whole uterine system is found black with blood. This phenomenon, and many similar, are instances of local action, a term which has indeed often been employed in a wider sense, but which, in the following remarks, is restricted to the meaning above illustrated.

If, in this attempt to elucidate the nature of local action, I should appear to have relied too much upon theoretical reasoning, perhaps I may be permitted to urge, that the case scarcely admits of the evidence of direct observation.

It will be granted that the cause of local action in any given part is some peculiar condition of the arteries or veins or both in that part, inasmuch as, with the exception of these vessels, the heart is the

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* The substance of these remarks has been introduced in my Anatomical Lectures during the last three years; and most of the facts in the present number have been mentioned in two courses of lectures.

only organ which influences the flow of blood, and the impulse, which it communicates, is of necessity general. It may likewise be assumed as probable, that the arterial trunks, in a part where local action occurs, if they are involved in it, contribute to its production in a similar manner with their capillary extremities.

There can be little doubt that an artery in a living human body is able to contract on a principle not very dissimilar to muscular irritability. One remarkable analogy would indeed suggest a contrary opinion. The arteries of a turtle, which are clearly irritable, have a distinct muscular coat, separate from, and internal to a fibrous tunic, which latter resembles considerably, and must be compared with, the fibrous coat in human arteries. A muscular coat is found as well in the larger veins of the turtle, which are irritable likewise. But if, where blood-vessels are indisputably irritable, muscular substance enters into their composition, it is likely that where this texture is wanting, irritability is also wanting *. To this instance, on the other hand, may be opposed still closer analogies drawn from warm-blooded animals. It was remarked

* It conduces extremely to distinctness in discussions respecting parts, which contract, to limit the terms muscular and muscle to express peculiarity of structure. The biceps flexor cubiti is a muscle, the heart is muscular, the detrusor urinæ is muscular, the uterus is fibrous, the middle coat of an artery is fibrous again, but different from either in structure. All these parts, however, are irritable.

by Mr. Hunter, that an artery exposed in a living animal gradually contracted. It is well known that if an artery is divided, of a size not to cause syncope, the blood, which at first gushes out in a large stream, after a few pulses is thrown in a stream sensibly narrower, becoming less and less, and finally stopping. This occurrence may be well observed, when arteries of the size of a crow-quill are divided in an ass. Again, I have observed that a portion of the carotid artery, upon being removed from a living ass, gradually contracts to half its first calibre.

It would further appear, that the larger arteries may become partially dilated without any apparent injury of their tunics, and, as it would seem, from relaxation only. If the carotid of an ass or large dog be exposed, and rubbed hard, at any point between the finger and thumb, for about half a minute or less, the artery will generally become sensibly dilated at that part. In most instances, in which I have produced this effect, I have subsequently found no lesion whatever in the coats of the vessel; and I have observed that on cutting out a portion of the artery, including the dilated part, the latter contracted gradually and proportionately as much as the adjoining tube: in one instance the internal coat was a good deal torn, which led me to vary the experiment. I tied a ligature round the carotid of an ass, so tightly as nearly to cut through both the inner and fibrous coat (as afterwards ascertained), and then immediately removed the ligature: the blood flowed again through the artery, and, for

the space of ten minutes, during which it was observed, the vessel did not appear in the least dilated at the line, where the ligature had been applied.

Now the case of local action, which I select as the best illustration of my hypothesis, is the phenomenon of blushing. In this instance, the capillary vessels of a more or less extensive, but partial surface, are found to contain on a sudden more blood than before; this distention might, it would at first appear, be accounted for equally well on the supposition of the coats of the vessels becoming either relaxed suddenly, or suddenly at some remoter point contracted; but an obstruction to the course of the blood in a large artery does not produce its enlargement on the side next to the heart, and, therefore, it is probable would not, if occurring in the capillary arteries. Again, blushing is contrasted with paleness. Of two opposite changes, the causes, it is to be presumed, are opposite; but unquestionably relaxation of the capillary vessels, or the absence of that usual obstruction, which consists in their narrowness, would not empty their tubes; and it is surely but consistent with common sense to suppose, that in sudden paleness of the surface, excepting or exceeding what directly results from a feeble action of the heart, the capillaries of the surface are contracted, and that in suffusion of the surface the capillaries are dilated, as the causes of either occurrence.

But this hypothesis, viz. that relaxation of the coats of arteries is the cause of their containing more blood

at one time than at another, derives its principal support from the facility and completeness, with which it explains all the circumstances characterizing different cases of local action. The vascular tumors, termed aneurysms by anastomosis, seem to form a variety under this head. What is most remarkable respecting these tumors is, that when they are cut into, the small vessels in their substance bleed for a longer continuance, and more furiously, than even the small arterial trunks, from which they are derived. Now, it will not be denied, that hemorrhage from small arteries is spontaneously stopped by the contraction of the divided vessels; but, in the instance before us, the hemorrhage does not cease, or, in other words, the divided vessels do not contract; and it is then clear, that this occurrence (if the tumor in question form a case of local action) is not inconsistent with the conjecture, that spontaneous dilatation of arteries is the essence of local action.

In the enlarging womb, in the mammæ, when preparing or fitted for their function, in short, in all parts where local action exists or has existed, the arteries are more or less tortuous. It has been supposed by one writer, that the tortuous form of arteries is a provision for an increase of their power, or a means of causing a determination of blood. To me it seems, on the other hand, more likely that this tortuous form is an effect of the change producing local action; and perhaps the facility, with which the conversion of straight into tor-

tuous arteries may be explained on the assumed hypothesis, may be urged as the principal strength of my argument.

It is obvious that a relaxed vessel, under the ordinary pressure of the blood, would be affected in the same way with a vessel not relaxed, under extraordinary pressure. Now, the latter case may be easily examined: when the carotid of an ass is exposed, and the animal put to no farther suffering, in a short time the artery is nearly at complete rest; there is little sensible alteration in its form or place, at each pulsation of the heart: if at this period the animal be put in pain, it struggles, the heart beats more vigorously, and immediately the carotid artery is thrown into a waving line, or becomes elongated and tortuous at each contraction of the ventricle; and thus, it may be presumed, would an artery, the fibrous coat of which should be relaxed, during the ordinary action of the heart, become elongated and tortuous likewise; and, consistently with the accommodating and modelling power of the body, in time permanently assume the form, to which it had at first been violently extended. In explaining on this principle the gradual increase of tortuousness in the temporal arteries, I have not to advert to any supposed difficulty in the ascent of the blood along these vessels (it being clear that gravity favours the entire course of the blood in those parts the veins of which descend), but simply to notice the frequency of local action in the head, as proved by the distinctness, with which the temporal arteries throb

on any casual excitement of the mind. The permanent and original curves of the internal carotid and vertebral arteries, secured by the forms of their channels in bone, are obviously contrivances of a very different nature. There can be no doubt, looking to the thin coats of the vessels of the brain, and to the analogy of the rete mirabile, that the double curve of each of these arteries, in human beings, is intended for the mechanical diminution of the force of the blood circulating in the brain.

One other case remains to be considered, in connexion with the subject of local action. In the aneurysmal varix the artery is found to be larger than before, and is said to be somewhat tortuous. I must, in this case, refer to the beneficent provisions of nature, many of which, even after the impairment of the human frame, directly tend to its renovation or support; and I would assume, that the artery is, in this case, specially relaxed through such an influence as regulates the action of the heart, in order that a competent supply of blood be conveyed to the limb, over and above that necessary to fill the vein, with which the artery communicates; an assumption at least consistent with the facts of the case.

With regard to the enlargement and tortuousness of the veins, in cases of local action, it is clear that there is nothing in these circumstances, which militates against my hypothesis. The effect of pressure upon veins is known to render them large and tortuous; as when a ligature is habitually tightened round a limb:

but it stands to reason, that, if the capillaries in a part are enlarged, the blood passing through them with less resistance than before, must exert more pressure upon the veins of that part.

In the preceding remarks, I have confined myself, as I proposed, to cases, in which the blood flows with more than usual freedom to a given part; a state which may or may not be conjoined with inflammation, with abundant, defective, or vitiated secretion; but which is obviously something quite distinct from each of these occurrences.

Remarks in Defence of the Hunterian Theory of Absorption.

The principal argument adduced in favour of the theory that absorption is performed by the lymphatic and lacteal vessels alone, is the following: that, as the lymphatics and lacteals are of similar structure, and pass alike through similar gland-like bodies, unite finally, and open by the same channel into the veins, it is analogically probable that their uses are alike: but the lacteals are known to be absorbent vessels, inasmuch as the chyle, which is formed in the small intestine, may be detected both in their minute orifices and in their trunks; and the lacteals, again, are likely to be the only absorbent vessels, as the chyle is not found in the mesenteric blood-vessels: the lymphatics, it is then analogically inferred, are absorbents likewise, and probably, with the lacteals, constitute exclusively the absorbent system of the body.

In further confirmation of this opinion, Mr. Hunter's experiments* went to prove, that milk, or a solution of starch and indigo, introduced into the intestine of a living animal, is found subsequently in the lacteals,

* Medical Commentaries, by Dr. William Hunter.

but not in the veins of the mesentery. M. Majendie found, that these experiments did not succeed on repetition. I have recently repeated them, and remarked an incident, which perhaps may have deceived Mr. Hunter in one case. When the mesentery is drawn out from the abdomen of a living animal, the lacteals generally contain more or less chyle: after a short exposure of the part, the colour of the lacteals changes from white to a clear blue. The first time that I observed this occurrence, it was subsequent to my having introduced a solution of starch and indigo into the adjoining intestine; and I concluded that an absorption of that substance had taken place; but, on scrutinizing the appearance narrowly, I found that the blue vessels contained no fluid, but were, in fact, empty; and I have since ascertained that the lacteals in adult asses, dogs, and rabbits, uniformly appear blue when empty, unless a light-coloured surface is placed beyond them. In the case in which Mr. Hunter observed the absorption of a white fluid, I am inclined to suppose, that the intestine contained, previously to the operation, more or less chyle, which, being afterwards absorbed, was supposed to be milk: at any rate, on throwing milk, diluted with a little hot water, into a carefully-washed portion of the small intestine of a young ass, which was then retained in the abdomen half an hour, I observed no absorption of a white fluid to ensue.

M. Majendie, in continuing this inquiry, made some interesting experiments, which are well known,

to prove that veins absorb. It was found that odorous substances, and poisonous solutions, found their way into the blood, when introduced into a portion of intestine, the communication of which with the system, except through a vein and artery, was entirely interrupted: whence M. Majendie inferred that the veins absorb; and in truth, without M. Majendie's own assistance, it would have been difficult to have escaped from this conclusion; for physiologists had assumed that transudation cannot take place in a living body; and though it is now clear, on a moment's reflection, that this assumption is untenable, and that the onus of proof lies with those who would assert it, not with those who disclaim it, it was left for M. Majendie and his immediate school to execute several very curious experiments, which lead to the opposite opinion, that transudation really occurs in living textures*.

But this principle once admitted, there is an end to the conclusiveness of M. Majendie's experiments, as decisive of venous absorption; and the broad analogical argument advanced by the Hunters to establish the position, that the lymphatics and lacteals form exclusively the absorbent system, remains unshaken. It must not be lost sight of, that the entrance of any substance, raw and unassimilated, into the veins and arteries, is a very different occurrence

* Journal de Physiologie experimentale.

from the conversion of the elements of the human body into lymph, and their subsequent readmixture with the blood; and, again, that the refusal of the lacteals to take up milk or starch, does not disprove that these vessels habitually absorb unchanged, and, in addition to the chyle, such simple fluids, as may be carried without detriment into the circulation.

Examination of a Body soon after Parturition.

The following account was drawn up, at my request, by my friend and pupil Mr. Taylor, who dissected the body, in which the appearances described below occurred.

In October last the body of a female, apparently about the age of thirty, was brought into Mr. Mayo's dissecting room: it was fat and muscular, not in any ways mishapen, and somewhat above the middle height of women. This person appeared to have died of uterine hemorrhage, a short time after delivery at the full period, for the uterus was very capacious, its substance 6-10ths of an inch in thickness, its orifice open, and, when disposed in a circular form, about two inches in diameter. Both the uterus and vagina contained a quantity of clotted blood. The inner surface of the uterus was thinly covered with shaggy processes of flocculent membrane, and appeared abraded here and there, and when the part was injected with size and vermilion, the injection escaped into the cavity of the womb, through many small orifices on its inner surface.

The muscles of the abdomen were found to have their usual appearance, except that the recti were between four and five inches asunder.

It was ascertained that the upper part of the vagina, where it joins the uterus, could be readily exposed without injury to the peritoneum, after an oblique incision through the fore part of the abdominal parietes.

The pelvis was well formed, and of the usual dimensions; but it was found that the sacro-iliac joint on either side was loose, so that the ileum and sacrum could be separated on each side to the extent of a third of an inch on the fore part of the joint. The ligamentous fibres, which run across from the ileum to the sacrum, were entire; but the usual connecting medium within, between the bony surfaces, was dissolved.

The symphysis of the pubes had been cut through before the condition of the sacro-iliac joint had been noticed. The sacro-sciatic ligaments were very lax.

Inquiries respecting the Structure of the Human Brain, by Professor Reil. Archiven für die Physiologie. Neunter-band, p. 136—208.

VIII.

I BELIEVE that I have successfully ascertained the structure of the greater part of the brain, namely, of the nucleus and convolutions of either hemisphere. I shall describe the former in the present treatise, and, subsequently, the remaining smaller parts, the anterior commissure, the fornix, the optic thalami, and the tubercula quadrigemina. I am sensible that my researches are in several points incomplete. The connexion between the nucleus of the brain and its convolutions, between that of the cerebellum and its laminated surface, has escaped me. I had nearly despaired of making any thing of the chain of ganglia, which occur in the brain; but latterly I have found out methods of examining those parts, which promise more success. I leave, for my last object, the final distribution of the vessels in the brain; an inquiry, which appears to me one of the greatest moment, and calculated to throw light on any remaining obscurities.

I am particular in describing the various methods, which I have adopted in preparing and dissecting brains, in order that every one may have it in his

power to verify with facility my remarks. At first I tore the brain in various ways, trusting to chance for a fortunate rent; but the appearances thus produced differed in each preparation, and I could not obtain a second result similar to the first. I now am able to point out definite methods, by which the organization both of the brain and cerebellum can be distinctly and readily shown at pleasure. The method adopted by Gall is insufficient. The brain without some preparation is not firm enough to allow of the separation of its parts, and contains, unquestionably, like the chrystalline, many layers, the distinction between which is not evident till the part has been coagulated. Very likely there exist still better methods of preparing the brain than those, which I have employed. Maceration in alkohol reduces the organ to 3-4ths of its original volume, and this circumstance may interfere with the ready separation of its parts. Maceration in an alkaline solution diminishes indeed, but does not obviate entirely the contraction produced by alkohol when employed alone. Maceration in [illegible] solutions, which are of so much use in unfolding [illegible] composition of nerves, is inapplicable to the [illegible] Both sulphuric and muriatic acid in water [illegible] brain too brittle for tracing the course [illegible] and can only be employed, with any [illegible] small portions of the brain, or [illegible] the are composed of parallel fib[illegible]

Of the methods which [illegible] [illegible]rkbundel]

[illegible]

answered best: 1. Let the brain be hardened in alkohol, and then placed in a solution either of carbonated or pure alkali, in the latter two days, in the former for a longer period, and then again hardened in alkohol, if thus rendered too soft. The advantage of this method is, that the fasciculi of nervous matter are more readily separable, and the brown matter more distinguishable from the white, than after simple maceration in alkohol: the gray matter is rendered by the alkali of a blacker gray, and assumes the consistence of jelly. 2. Let the brain be macerated in alkohol, in which pure or carbonated potass or ammonia has been previously dissolved: the contraction of the brain is lessened by this process. 3. Let the brain be macerated in alkohol from six to eight days, and then its superficial dissection commenced, and the separation of the deeper parts continued, as the fluid, in which the brain is kept immersed, penetrates its substance. This method appears to me better than the preceding, and would very likely be improved, if the alkohol were rendered alkaline. The fibres in a brain, thus prepared, are more tenacious than otherwise, and the deeper parts are sooner exposed to the influence of the alkohol. The epithelium tends especially to prevent the penetration of the alkohol; it would be well always to remove it entirely or in part from the surfaces of the brain, which it covers. Specimens of the cerebellum, which have remained several years in alkohol, sometimes exhibit with unusual distinctness the fasciculated structure.

I have not yet tried other methods, such as maceration in solutions of corrosive sublimate, and of liver of antimony, the application of heat, dissection under water, and the like, which may perhaps exceed those, which I have adopted.

I have used, as instruments in dissection, my fingers alone, the handle of a scalpel, a pointed instrument, an ivory knife, rounded at the extremity, and another with a straight edge, and a curved and half-sharpened back: these instruments are to be employed upon the layers that cover the surface, which it is desired to expose, and the parts are to be so bent as to throw forward the surface, of which the dissection is to be made.

It has struck me that preparations in wax might be of service in representing the various appearances, which are made out by dissection of the hardened brain.

Let me now explain various terms, which I have found it convenient to employ in the description of the brain.

The epithelium is a leathery substance, partly membranous, partly consisting of nervous matter, which invests such medullary surfaces of the brain, as want other coverings.

The medulla incognita [ungenannte marksubstanz] is placed near to, and somewhat parallel with, the optic nerves.

The hamular fasciculi [haakenförmige markbundel]

connect the anterior and middle lobes of either hemisphere at the entrance of the fissura Sylvii.

The covered bands [bedeckten bänder] are situated on either side of the raphe, within the two convolutions, which are in immediate contact with the corpus callosum.

As belonging to the fornix [zwillingsbinde des balkens] may be noticed, its root in either thalamus, its nodules the corpora albicantia, its anterior crura, its body, or that part where the lateral portions cohere together, the part termed the lyra, and the posterior crura, terminating in the hippocampi.

The island [insel] is the oval floor of the fissura Sylvii, on which are placed small and low convolutions, surrounded by a furrow: the entrance of the fissura Sylvii is its lower and anterior extremity.

The corpus striatum [gestreifte vördere, grosse hirnganglium] consists of two parts, one external, the other internal to the substance derived from the crus cerebri.

The medullary capsule [kapsel] is the substance immediately enclosing the outer portion of the corpus striatum: the external part of the medullary capsule is that surface, which supports the convolutions of the island.

The corpus callosum is terminated by an anterior fold [das knie des balkens], the extremity of which is narrowed [das schnabel], and again by a posterior fold [die aufgesetzte wulst].

The tapetum [tapete] of the corpus callosum is a layer derived from it to line the roof of the posterior horn of the lateral ventricle.

The fibres derived from the crus cerebri, which diverge at the upper margin of the thalamus towards the circumference of either hemisphere, form the fibrous cone [stabkranz].

The disposition of the fibres in the brain is various; those in the convolutions are disposed in medullary plates, which are arranged on the same principle with the plates in the laminæ of the cerebellum; but there is some difference and more intricacy in the structure of the convolutions, from the circumstance that the latter are not parallel with each other, but unite at various angles. In the anterior commissure, and in the fornix, the fibres are flax-like and reticular, in the crus cerebri and corpus callosum they are disposed in parallel flattened fasciculi; in the outer wall of the medullary capsule, the fibrous cone, and the tapetum, their disposition is radiated.

The cerebrum is placed upon the crura cerebri like the top of a mushroom upon its stalk. Like the cerebellum, the cerebrum consists of a nucleus, in which the ventricles are contained, of parts, in this case called convolutions, which are external to the nucleus, and of gray substance, which lies partly within, partly on the surface.

The nucleus is composed again of the parts continuous with the crura cerebri, or vertical portion, and of the corpus callosum, and fornix, or horizontal

portion. These, with the convolutions, and their gray matter, appear to constitute the essential elements of the brain; the rest to be only for the purpose of establishing communication between remote parts. Thus, between the nucleus and the convolutions, a medullary layer exists, specially observable near the fissura Sylvii, which consists of distinct fasciculi extending between distant convolutions.

IX.

Of the vertical Portion of the Nucleus.

The whole extent of the vertical part of the nucleus on either side of the brain, from the beginning of the pyramid to the bases of the convolutions, forms a single organ; in the same way the horizontal part of the nucleus forms another complete organ.

The pyramids are parts of the medulla oblongata; at the fore part of which, about ten or fifteen lines below the annular protuberance, several medullary fasciculi cross obliquely over from one side to the other. This decussation is best exposed by partially separating the lateral portions of the medulla oblongata from behind at the calamus scriptorius, when the white fibres alluded to are seen to join the nucleus of the spinal marrow a few lines below their crossing, and above it to form the pyramids. Like the crura cerebri, and the corpus callosum, the pyramids appear to consist of parallel medullary fasciculi, which, in the

latter case, form two fibrous cylinders: these are contracted just before they enter the annular protuberance, in which their fibres are again spread out, and form several layers interwoven, at right angles, with the transverse fibres derived from the cerebellum.

Beyond the annular protuberance, the white fasciculi derived from the pyramids continue to ascend, forming the anterior and inferior surface of the crus cerebri, external to which are seen the fillet and the corpora geniculata on either side. Upon detaching and turning aside the tractus opticus, the superficial fibres of the crus cerebri are found extending towards the posterior and inferior horns of the lateral ventricle. Behind the transverse fibres of the annular protuberance, and between the middle peduncles of the cerebellum, or at the floor of the fourth ventricle, covered only by gray matter, is found a thick and broad stratum of longitudinal fibres, which, in its ascent from the medulla oblongata, is joined on either side by the fillet. These two substances are as yet unconnected with the pyramids, but, subsequently, contribute to the radiation of the vertical part of the nucleus. At the angular hollow, from whence the third pair of nerves emerges, a medullary fasciculus often separates itself from the ascending fibres, and passes round the crus cerebri in a direction from within outwards.

The fasciculi of the vertical portion, from their entrance into the annular protuberance upwards, are continually enlarging and diverging, but to a more remarkable degree after they emerge from that body.

If a transverse section be made of the crus cerebri, it appears that the nervous fibres derived from the pyramid form a thick inferior crust, disposed in flattened longitudinal fasciculi, the edges turned inwards and outwards; above which, and inclosed by it, a distinct and more or less cylindrical mass [der haube, it may be called the cylinder of the crus cerebri,] occurs, which comprises all the parts situated at the floor of the fourth ventricle between the lateral peduncles of the cerebellum, the black substance, the tubercula quadrigemina, the thalamus, and, lastly, the inner portion of the corpus striatum. If a section of the crus cerebri be alternately dried and reimmersed in alkohol, the layers of the crust may readily be peeled off from the remaining part, and are found to extend to the depth of two lines.

The vertical portion of the nucleus is throughout connected with gray matter, which in part covers it, and in part is interwoven with its medullary substance; thus, above the pyramids, is placed the gray substance of the medulla oblongata; and in the annular protuberance gray matter intervenes between the separated fibres. Above the annular protuberance, the ascending fasciculi are clothed internally with the gray matter, which extends backward from the corpus striatum, along the third ventricle, to the margin of the annular protuberance. On the outside of the ascending fibres, gray matter, from the tubercula quadrigemina, extends downwards and backwards with the fillet; and between the anterior and lateral

peduncles of the cerebellum, reaches the annular protuberance, with the gray matter of which it is continuous. The black matter again is interposed between the crust and cylinder of the crus cerebri, and seems to give origin to the third pair of nerves. Further forward, the fasciculi of the vertical portion of the nucleus are covered by the tubercula quadrigemina, and by the thalami, and are finally, in great part, lodged between the two portions of the corpus striatum; from either of which cross processes of gray matter pass through the ascending medulla.

The fillet of either side, traced from the annular protuberance upwards, divides into two portions, one of which passes inwards, to join its fellow of the opposite side, so as to form a curvilinear stratum of fibres immediately below the tubercula quadrigemina: the other plunges below the corpus geniculatum internum, into the thalamus of the same side, and extends apparently to join the fibrous cone. Below the fillet, again, the anterior peduncle of the cerebellum extends in a direction inwards and downwards towards the black matter, to contribute, probably, to the radiation of the vertical portion. Either thalamus consists of several layers, each layer of gray and white matter, the former internal. The superficial layer has a fibrous structure, and peels off readily in the direction from before backwards. Between this and the next the root of the fornix lies; so that by tracing the latter from the corpus albicans the interval between the two inner layers is at once found. The superficial layer

is continuous behind with the tractus opticus, with the fibres, which, clothed with the tapetum, form the roof of the inferior horn, and above with the tænia semicircularis geminum: the latter substance is a cord of flax-like fibrils, which extends forwards to where the crus of the fornix meets the septum lucidum, behind the anterior commissure; it is in contact with the fibrous cone; it assists in forming the tapetum of the inferior horn of the lateral ventricle, and it gives fibrils to the tractus opticus. The second layer is a production of the corpus geniculatum internum, which expands either way, so as to inclose the posterior margin of the crus cerebri; its outer fibres, passing towards the outer portion of the corpus striatum, join the fibrous cone. The third layer is that derived from the fillet, which has been already spoken of. The substance of the thalamus is thickest below; the white fibres, which proceed from its internal substance, ascend obliquely outwards, and at the upper and outer margin of the thalamus unite with the fibrous cone, partly interlacing with, and decussating that substance, as may be seen on raising in succession, after dividing the crus cerebri, in a separated hemisphere, the first, second, and third layers of the thalamus, and carrying the rent forward: then, too, is seen the regular disposition in parallel fasciculi, which the crust of the crus cerebri maintains, till, blending with the fibres last described, it with these forms the fibrous cone, whence are derived fasciculi towards the circumference of the hemisphere, the longest to the posterior, and the next in length to

the anterior lobe. At the entrance of the fissura Sylvii, this arrangement, otherwise uniform, is interfered with; an obscurely organized substance, the medulla incognita, [ungenannte Marksubstanz,] occupies this surface in the base of the brain; it contains part of the anterior commissure, is continuous before with the thalami, laterally with the pes and tænia hippocampi, and thus encircles the outer margin of the crus cerebri, being exposed on the removal of the tractus opticus.

The anterior and middle parts alone of the fibrous cone are enclosed between the two portions of the corpus striatum; for this extent its outer fibres form the inner surface of the medullary capsule. In the entire vertical process, the coarser fasciculi, which are formed by the union of many delicate fibrils, resemble more or less, but most in the crus cerebri, the sticks of a fan; these flattened fasciculi, from the annular protuberance to the fibrous cone, are disposed somewhat circularly, their edges looking inwards and outwards; but in the fibrous cone their disposition more resembles that of the sticks in a closed fan; they at first, at least, lie nearly in one vertical plane; each fasciculus has a distinct but delicate sheath of cellular membrane *. The fasciculi of the fibrous cone con-

* The epithelium consists of a fine transparent production of the pia mater, and a layer of nervous matter within this, either white or gray; it admits of very distinct

tinually diverge in their course towards the circumference of the brain. The foremost fasciculus attaches itself to the curved central part of the anterior commissure; or the anterior commissure passes between the first fasciculi of the fibrous cone, and then spreads itself out in the under surface of the middle lobe. The anterior fasciculi are long and delicate; the middle fasciculi the shortest and the thickest, being more cylindrical, and principally employed in the formation of the pecten; the posterior fasciculi are the longest; those which pass to the neighbourhood of the inferior horn are somewhat shorter; the two latter sets are not interwoven with gray matter; the two former alone are interposed between the outer and inner portions of the corpus striatum, cross processes from which interlace with the medullary fasciculi for this extent: the largest of these cross processes is the foremost among them; this series of

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demonstration on the septum lucidum. Where the corpus callosum joins the outer margin of the corpus striatum, the epithelium appears to split into two layers; one of which invests the inner surface of the corpus striatum, the other passes between its gray matter and the fibrous cone, each fasciculus of which it seems to clothe down to the margin of the optic thalamus. It is probable, so general is the obvious distribution of the membrane, that each plate, even in the convolutions, has a tunic derived from it.

intersections forms the pecten; it sometimes reaches as far back as the posterior margin of the optic thalamus; fine medullary processes, derived from the tænia, pass outwards into the pectea, in a similar direction with the gray processes. Upon the outer margin, likewise, of the corpus striatum a substance is found, which fills the interval at the meeting of the vertical and horizontal portions of the nucleus, where the middle fasciculi of the fibrous cone are bending forwards: it eventually joins the tænia semicircularis; after which, with the tænia, it passes around the outer margin of the thalamus along the inferior horn of the lateral ventricle, uniting finally with the medulla incognita. From this last described substance, again, medullary fibrils, every where mixed with gray matter, are given off, which pass, like teeth, into the pecten.

The foremost fasciculi of the fibrous cone pass straight towards the corpus callosum; those which are next in order, on its internal surface, have an inclination forward, which takes place in the structureless layer just mentioned as lying at the exterior margin of the corpus striatum; these internal fasciculi apparently proceed from the thalamus; the external fasciculi, which are derived from the crus cerebri, pass in a straight direction. The posterior fasciculi of the fibrous cone, which are immediately clothed by the tapetum, pass horizontally from the posterior margin of the thalamus towards the point of the posterior lobe, are from two to three lines in thickness, and several inches in length. The fasciculi

which extend to the middle lobe are inclined downward, and those which belong to its anterior extremity are again somewhat inclined forward. The fasciculi of the fibrous cone radiate from the thalamus as from a centre, and their direction varies with the inclination of its margin. The posterior extremity of the thalamus divides into two parts, one of which, that namely continuous with the tractus opticus, covers the other, which is obtuse, and contributes to form the roof of the inferior horn. The radiated expansion of the anterior commissure blends with the fasciculi of the fibrous cone. In order to show this circumstance, the anterior commissure must be exposed, the tractus opticus turned back, and the fasciculi of the crura cerebri, which it covered, followed in their upward and outward course. At the roof of the inferior horn there are found, besides the epithelium, the tapetum formed from the corpus callosum and tænia semicircularis geminum; then a layer derived from the obtuse end of the thalamus; and finally the layer derived from the crus cerebri and the anterior commissure. Externally to all these a layer of long fibres is found to extend from the fore part of the middle lobe to the extremity of the posterior lobe, where it blends with those of the fibrous cone. The portions of the latter belonging to the inferior and posterior horns lie quite behind the outer portion of the corpus striatum, but are covered for a short extent by the tail-like prolongation of the inner portion. Hence they are not traversed by transverse processes

of gray matter, but the fasciculi are uniformly in close apposition. From the portion included between the two parts of the corpus striatum, very fine filaments are derived, which penetrate the substance of the latter.

The posterior fasciculi of the fibrous cone, extending along the outside of the posterior horn, finally lose themselves in the neighbouring convolutions. Its anterior fasciculi are joined from without by the fibres radiating from the outer wall of the capsule; both together, intermingled and interwoven, extend to the corpus callosum. Where the two systems join, a ridge is left on breaking away the investing substance, as when the hemispheres are rent away from the upper surface of the corpus callosum. Behind, the radiation of the outer wall of the capsule blends with that of the fibrous cone, and near the inferior horn to both are joined the radiation of the anterior commissure.

To prepare for this demonstration, a brain separated from the cerebellum by a section of its crura, and deprived of its upper part, by an horizontal section above the corpus callosum, stripped of its membranes, and vertically opened from its base by a section in the median plane, extending to the fornix, or even so divided, and either posterior horn longitudinally cut into, is to be hardened in alkohol, then softened as above described, and rehardened. A person accustomed to this dissection may begin it with advantage on a brain only eight days hardened in alkohol, taking care to stop

where the alkohol has not yet coagulated the medullary substance.

The first step in the dissection is to expose the outer wall of the medullary capsule, in the manner presently described, with the course of the anterior commissure to the middle lobe. The brain may then be readily spread open from below. The epithelium is afterwards to be removed from the under surface of the corpus callosum: that covering the corpus striatum in the lateral ventricle to be cut through longitudinally, and one half drawn off towards its upper margin, the other towards the thalamus. The tænia semicircularis geminum is then to be raised in the direction from behind forwards, by which means the pecten is exposed. In a similar manner the inner portion of the corpus striatum is to be raised, into which delicate fibrils may then be seen to enter from the fibrous cone, which is denuded by its removal; and next, the structureless medullary substance, in which part of the ascending fasciculi are incurvated forward, and which lies along the upper margin of the inner portion of the striated body. The separation being now carried down to the fore-part of the anterior commissure, exposes the foremost fasciculi of the fibrous cone, before which the two portions of the corpus striatum are seen to unite by means of a broad process. Then, in the opposite hemisphere, the tænia semicircularis geminum may be raised so as to show the toothlike processes derived from it, and entering the

pecten. The cauda of the inner portion of the corpus striatum may be next removed, the thus exposed edge of the tapetum divided, a section of the tapetum carried to the point of the posterior horn, and either portion of it turned aside. To show the organization in the inferior horn, the tractus opticus is to be turned back to its corpus geniculatum, and the obtuse extremity of the thalamus thus exposed, which radiates above the tapetum into the inferior horn. Through these means are brought into view the outer and upper packets of the crura cerebri, which bend backwards abruptly, and expand themselves above the last described stratum, with which they blend. The outer surface of the vertical portion of the nucleus yet remains to be shown. The medullary capsule is already exposed: the medulla incognita is now to be pressed away from the crus cerebri from behind forward, the anterior commissure to be cut through, the anterior crus of the fornix laid bare to the corpus albicans, the outer wall of the capsule to be removed, and the gray matter within it extruded. It remains to raise the [illegible] quadrigemina in the course of the anterior [illegible] of the cerebellum, to [illegible] from [illegible] layer of the thala[illegible] black [illegible] posed, which lin[illegible] rived from [illegible] e in order that [illegible] of [illegible] halamus [illegible] on- cerebri may [illegible] ucit [illegible] pared [illegible] n ovale [illegible] nvolution

X.

Of the horizontal Portion of the Cerebral Nucleus.

To either surface of the corpus callosum three longitudinal bands adhere. Above, and in the median plane of the body, the superior raphe extends from the anterior to the posterior fold of the corpus callosum; below, and opposite to this, a similar band is found, like the former, furrowed centrally; to the edges of its furrow the two layers of the septum lucidum are attached; behind, the inferior raphe continues in a straight direction to the posterior fold of the corpus callosum, blending with which and with the fornix it terminates. In its course it appears to give and receive fibrils from the corpus callosum. Between the superior and inferior raphe, or in the median plane, the corpus callosum is rather contracted, and its fasciculi are more closely woven.

Parallel with, and on either side of the superior raphe, may be found a flattened medullary fasciculus, which, lying concealed by the convolution in contact with the upper surface of the corpus callosum, is termed the covered band. The convolution alluded to may be traced from the fore and lower part of the anterior lobe, where it is reflected forward from the convolution touching the root of the olfactory nerve; thence advancing forward and overlapping the an-

terior fold of the corpus callosum, then continuing along its upper surface in a line unbroken, except towards the posterior fold by some vertical indentings, and finally sweeping downward and forward again, and skirting the aperture of the inferior horn. Either posterior crus of the fornix, which is at first composed of medullary substance alone, derives from this extended convolution a supply of gray matter, which is contained in its navicular cavity, and thus the hippocampus major is formed. When this convolution is turned aside, the covered band is seen, which may easily be raised from its adhesion to the corpus callosum: externally to it the fibres of the latter lose their former fasciculation, and are arranged in delicate plates, more closely attached to each other. The covered band of either side turns round the anterior fold of the corpus callosum, extends to the anterior commissure, and brings away with it, when raised, all the convolutions which belong to the inner and central part of the anterior lobe: in like manner it turns round the posterior fold, becomes continuous with the posterior crus of the fornix and the long convolution above described. Thus on either side the covered band forms a circle round the root of the hemisphere, unbroken except at the entrance of the fissura Sylvii. To show the covered bands, it is convenient to make an horizontal section of a prepared hemisphere, as for the exposure of the centrum ovale minus; then vertically to divide the long convolution

and the covered band itself: the latter may be raised from this point in either direction.

The fornix on the under surface of the corpus callosum is to be compared with the covered bands of the upper. The use of these parts is apparently that of longitudinal commissures.

The corpus callosum has a similar structure with the crust of the crura; it consists of flattened fasciculi, which are disposed transversely with their edges turned upward and downward: hence the appearance of transverse grooves on the surface, the readiness of tearing this substance across, and the impossibility of accomplishing this evenly in any other direction. Each flat fasciculus consists of many delicate plates. The closer grain of this substance in the median plane is particularly well seen at the concave surface of the anterior fold, from which, as from a centre, the fasciculi seem to radiate in all directions. The texture of the corpus callosum is coarse within, and fine without the covered bands. No one fasciculus is entire and disconnected, but gives to and receives fibrils from those adjoining, as may be seen on drawing asunder the extremities of the corpus callosum. There exist likewise in its substance fasciculi much finer than the general run of the coarser fasciculi, which yet are as separable and distinct as the latter.

The anterior fold of the corpus callosum is thickest at its abrupt bend, whence it tapers downwards and backwards; its final margin, reaching the anterior crura

of the fornix, throws off to either side a medullary line, which passes between the optic nerves and the lamina cribrosa, and disappears below the obtuse extremity of the middle lobe; the anterior commissure is placed immediately over this line. Laterally, the extremity of this fold is continuous with the thin medullary layer, which supports the convolutions of the internal and under surface of the anterior lobe, and in conjunction with the lamina cribrosa forms the inferior wall of the capsule. The concave surface of this fold forms a centre of radiation for the fasciculi of the fore part of the corpus callosum: to it is affixed the anterior extremity of the septum lucidum, the two plates of which enclose a ventricle, allowing an expansion of two short horns at its fore part, and contracting it behind to a pointed termination on the lyra. The plates of the septum adhere at the fore part to the edges of a broad furrow in the corpus callosum, in which the inferior raphe is contained; and behind, to the crura of the fornix. The fasciculi, which radiate from the anterior margin of the corpus callosum, meet the anterior fasciculi of the fibrous cone. Those, which radiate from the anterior fold below this, bend round the obtuse margin of the fibrous cone. Those which are derived from the main portion of the corpus callosum meet at an acute angle, and sometimes directly anastomose with the middle fasciculi of the fibrous cone, and with those derived from the inner and outer walls of the capsule. The apparently structureless medullary substance is con-

tracted here to a narrow line, and eventually joins the tænia semicircularis, and is covered by the gray substance of the extremity of the corpus striatum, and by the epithelium. The deeper fasciculi of either system seem most directly to anastomose, and the inner layer alone of the corpus callosum to pass below, and unconnected with, the fibrous cone. The middle part of the corpus callosum is in connection with the convolutions of the inner surface of either hemisphere, with those of the vertex, and finally with those of the roof of the fissura Sylvii.

The fasciculi, which form the posterior margin of the corpus callosum, are arranged in a full roller-like fold: a small portion of this is destined to unite with the fornix and the long convolution, and to extend into the hippocampus. The greater portion expands to form the tapetum of the posterior horn, the fibres of which line the fasciculi of the fibrous cone, crossing the latter at an angle. Sometimes, especially in the neighbourhood of vessels, gray matter is found between the tapetum and the medullary substance, which it covers. The fasciculi of the corpus callosum, which are placed a few lines before its roller-like posterior margin, passing behind the thalamus, form a sort of woven suture with those of the fibrous cone which they cross. The tænia and slender extremity of the inner portion of the corpus striatum are interposed between the posterior edge of the thalamus and the fasciculi last spoken of. The former substance contributes a tapetum on the outside of the thalamus;

elsewhere, in the inferior horn, the tapetum, which is but thin, is derived as above, and its fibres have a similar direction with those of the fibrous cone. The tapetum is thickest about the middle of the roof of the posterior horn.

The mode of connection between the fasciculi of the vertical and horizontal portions of the nucleus forms an interesting subject of inquiry. It varies seemingly. In the anterior horn, especially near the fold of the corpus callosum, where the fibres of that substance tend towards the obtuse margin of the fibrous cone, the two systems meet abruptly, and in the angle is found an apparently structureless medulla. Behind this the superior layers of the corpus callosum anastomose with the fasciculi of the fibrous cone. Again, at the posterior margin of the thalamus, and for a distance of two lines from that body, the fasciculi of each system decussate each other, and are interwoven. Finally, the posterior portion of the corpus callosum is extended as a distinct and separable layer within the expansion of the fibrous cone.

The two systems now described form the nucleus of the brain. Between this and the convolutions of each hemisphere, however, another structure is found, afterwards more particularly described: it consists but of fasciculi which pass from the centre of any convolution to others more remote. It is probable that the convolutions receive fibres both from these fasciculi and from either portion of the nucleus.

To prepare a brain for the demonstration of the

horizontal portion of the nucleus, the hemispheres should be removed by an horizontal incision above the corpus callosum, then laid open from below, the floor of the posterior horn cut through longitudinally, and that of the inferior horn transversely at its extremity, in order that the alkohol may have free access to every part. In the subsequent dissection, the convolutions bordering on the posterior fold of the corpus callosum are to be raised by drawing off the covered bands, in the way already described, which operation will expose the course of the fasciculi of the corpus callosum to their destination, as roof and floor of the posterior horn. The incision directed through the floor of the inferior horn is to allow of the eversion of the hippocampus major, and the exposure of its navicular cavity filled with gray matter. Upon the inner surface of the posterior lobe the small posterior fissure is found, next to that of Sylvius the most remarkable. This fissure is deep; it extends vertically upwards from the convolution which laps round the posterior fold of the corpus callosum, along the inner surface of the posterior lobe, over the upper margin of the hemisphere, on the summit of which it terminates: it thus skirts the inner surface of the posterior horn, and one of its indentings has a corresponding prominence in that cavity. The exterior wall of the lower part of the fissure is carefully to be broken off, in order to expose the fasciculi which surround the posterior horn: it will then be remarked that the fasciculi of the under surface of the posterior fold of

the corpus callosum are extended first transversely; that they are then prolonged into two bands, which extend to the point of the posterior horn, and are joined at their internal concave margin; while, from the extreme anterior margin of the inflected fold fibres are derived, which expand, fan-like, to complete the walls of the posterior horn: with these the posterior crura of the fornix are partly united, which also are extended along the inferior horn, contain gray matter continuous with that of the adjoining convolution, and with it form the hippocampus major. The white matter of the hippocampus thus derived is continuous internally with the tænia hippocampi; externally is reflected to form the internal layer of the white matter in the internal and inferior convolution of the middle lobe: the layer opposed to this, again, forms the immediately adjoining part of the floor of the inferior horn: it follows that, at the meeting of the two layers, this convolution splits in its axis. The gray substance in the hippocampus allows of being rent in its centre, but is very unmanageable.

The inner surface of the corpus callosum may now be deprived of its epithelium, which may best be done by separating the two layers of the septum lucidum below, carrying the rent upwards, and, when it reaches the corpus callosum, inclining it horizontally; the tapetum then readily peels off, and, at the same time, the furrow belonging to the internal raphe is fairly exposed. The removal of the epithelium exposes the tapetum, or lining, of the ventricular

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cavity; at the fore part it is necessary to turn aside the posterior extremity of the tænia semicircularis geminum, and the narrow tail of the internal portion of the corpus striatum: finally, the tapetum itself may be raised with the edge of the knife, introduced at the posterior edge of the thalamus, and the posterior divergence of the fibrous cone exposed, in like manner as its anterior radiation is exhibited, on the removal of the inner part of the corpus striatum.

Explanation of the Ninth Plate.

In order to exhibit the parts represented in this plate, a fresh brain should be treated in the following way: the upper part of the hemispheres should be removed, by horizontal incisions, a little above the corpus callosum; the brain being then reversed, is to be deprived of the cerebellum, and upon this laid open from below, by means of an incision in the median plane, through the tubercula quadrigemina, the gray substance at the floor of the third ventricle, the infundibulum, the commissura tractuum opticorum, and the commissura mollis: vertical incisions parallel to this, beginning with either posterior crus of the fornix, are to be carried to the point of the posterior horn of either lateral ventricle. The plexus choroïdes being next removed, the brain is to be hardened in alkohol, then softened in an alkaline solution, and afterwards again hardened. The covered bands are

now to be taken off, so as to give freedom to either extremity of the corpus callosum, and then the island; the removal of which allows the separated portions to be freely bent away from each other.

In doing this, it is necessary to cut through the anterior commissure, and to separate from the body of the fornix its anterior crura; the roots of these bodies, extending from the corpora albicantia into the thalami, may be exposed. The narrow end of the anterior fold of the corpus callosum is to be separated laterally from its connexion with the outer part of the corpus striatum and the under surface of the capsule. The epithelium is now to be drawn from the under surface of the corpus callosum, the tapetum shown, and the radiation above it of the fibrous cone.

The present plate is rather a plan than a drawing, designed from separate portions of hardened brains, and contrived so as to show more parts than can well be exhibited, at one view, in an accurate drawing.

A. A. The anterior,

B. B. The middle,

C. C. The posterior lobes of the brain.

a. A very imperfect representation of the medullary process, which extends from the anterior inflection of the corpus callosum to the under surface of the capsule.

b. The anterior fold of the corpus callosum, turned forward, so as to show the great divergence of its

fasciculi at this point, and the furrow of the external raphe.

c. c. c. c. c. Five curved lines, to show the corresponding points in the fibrous cone, and in the everted fold of the corpus callosum.

d. A point, at which the fasciculi of the corpus callosum are separated, to show their breadth.

e. Section of the commissura tractuum opticorum: on the right side, the passage of the tractus opticus to the thalamus is represented.

f. Section of the anterior commissure.

g. The foremost fasciculus of the fibrous cone.

h. The adjoining fasciculi, having an inclination forward.

i. A point at which the fasciculi of the fibrous cone appear to be continuous with the deeper fasciculi of the corpus callosum; the latter being exposed by the removal of the tapetum.

k. The right thalamus.

l. Section of the right crus cerebri*.

m. The second layer in the thalamus exposed, with the anterior portion of which the root of the anterior crus of the fornix is seen to be continuous.

n. n n. Different parts of the fornix.

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* Through an inadvertence, the letter *l*, in this plate, is crossed, so as to represent a *t;* but the error is too gross to mislead.

o. o. Part of the long convolution, which surrounds the corpus callosum: its adhesion to the posterior fold of the latter, and connection with the posterior crus of the fornix, from the general union of which the hippocampus is derived, are seen.

p. The posterior fold of the corpus callosum, thickest centrally.

q. Its prolongation into the hippocampus minor, on the right side.

r. The same, on the left side, cut through, and turned back.

s. Section of the tapetum, its greater thickness at its middle.

t. The radiated expansion of the fibrous cone towards the posterior lobe, seen on the partial removal of the tapetum.

u. An imperfect representation of the fasciculi furnished to the roof of the inferior horn from the external margin of the thalamus.

v. The inner portion of the corpus callosum of the left side.

w. The tænia semicircularis geminum, left anteriorly in its natural place, behind drawn aside, so as to show its inferior medullary surface, and the fasciculi, which, teeth-like, plunge into the pecten.

x. A small portion of the fibrous cone, exposed by a partial removal of the tænia semicircularis.

y. y. The corpus albicans of either side; the formation of that on the right alone exposed.

z. Section of the tubercula quadrigemina and crura cerebri.

1, 1. The tapetum, extending from the corpus callosum and its posterior fold, to form the surface of the posterior horn of the lateral ventricle.

2. A point, at which the fasciculi of the tapetum are apart, and those of the fibrous cone exposed.

3. The tapetum of the inferior horn of the lateral ventricle, which is partly derived from the corpus callosum, partly from the tænia, and from the thalamus. The representation is imperfect.

XI.

Of the Fissura Sylvii, of the Striated Body, and of the Medullary Capsule.

The fissura Sylvii extends, from its commencement below, obliquely upwards and backwards for more than a third of the length of the brain. The boundary of the fissure belonging to the anterior lobe may be termed its roof; that belonging to the middle lobe its floor; the roof and the floor meet behind at an acute angle; intermediately they inclose a space, covered with low convolutions, which are surrounded by a gutter-like depression. These low convolutions, which form the island, are placed upon the hamular fasciculi. Below the fissura Sylvii, and parallel with its floor,

extends a linear fissure, frequently four inches long. A section through the hemisphere, taken from the anterior part of the gutter, shows its medulla to be a full inch in thickness.

For the examination of this surface, it is convenient to remove, by an horizontal incision, beginning about half an inch above the corpus callosum, the upper part of a detached hemisphere; and, while hardening the remaining part, to keep the fissura Sylvii open by means of portions of cork interposed between its roof and floor. The process of hardening, as already described, having succeeded, the tough and flexible mass is to be so bent, as fully to expand the fissura Sylvii, and to expose the island. Then, on a convolution of the floor, a superficial rent, parallel to its axis, may be made, and carried towards the gutter surrounding the island; in a similar way, from all the convolutions inclosing the fissure, a layer may be peeled, and the rent then carried over the island, which will bring away the greater part of its convolutions. Finally, a rent may now be carried along the axis to the base of a convolution of the roof; which rent, when directed backward from the base of the convolution across fissure, will raise the long fasciculi extending from the anterior to the middle lobe: these are the hamular fasciculi; they are better seen when raised in slender filaments.

The outer portion of the corpus striatum is inclosed in its capsule, which has three surfaces; an outer and an inner wall, and a floor.

The floor consists of the medulla incognita, of the lamina cribrosa, and of the bases of the convolutions, which are in contact with the root of the olfactory nerve; it extends inwards towards the apex of the anterior fold of the corpus callosum, backwards towards the posterior margin of the crus cerebri, outwards to the hamular fasciculi. The floor and outer wall are readily peeled off from the gray matter, when the union of the two portions of the corpus striatum, before the margin of the fibrous cone, may be distinctly seen. If the tractus opticus be raised, and the medulla incognita, along with the lamina cribrosa, be removed from the crus cerebri, it is easy to follow the anterior commissure, passing through the corpus striatum, above the hamular fasciculi, to its fan-like expansion in the outer wall of the inferior horn, where its fibres meet with the external fasciculi of the fibrous cone.

The outer wall of the capsule is composed of a portion of the hamular fasciculi. The fasciculi, which pass from the inner and under convolutions of the anterior lobe, near the root of the olfactory nerve, and thence extend across the fissura Sylvii to the prominence forward of the middle lobe, are thus employed: their outer extremity closely blends with the fan-like expansion of the anterior commissure: fine fibres from the latter may be traced to the medulla incognita and to the tænia.

The fasciculi above specified contain the centre nearly of the radiation of the entire outer wall of the

capsule: here the fasciculation is finer, as well as somewhat laminated, which, towards the superior convex margin of the gray mass, is coarse. At the upper margin of the outer part of the striated body, the outer and inner walls of the capsule meet at an acute angle, decussate each other, and are interwoven: here, too, the fasciculi of the fibrous cone, and those of the corpus callosum meet, and one general and intricate intermixture of fibres, from all these sources, occurs. In connection with the fasciculi of the fibrous cone, the hamular fasciculi extend as far back as the end of the posterior lobe; inwards, towards the corpus callosum; downwards, to the inferior horn of the lateral ventricle.

Besides what is strictly the outer wall of the capsule, there may be raised, after the general removal of the convolutions, other medullary fasciculi, which have passed from the centre of the base of one convolution to that of another, connecting not merely adjoining, but even remote convolutions: these are especially found within the convolutions of the roof of the fissura Sylvii, whence they pass round the island to convolutions in the middle lobe: this structure is probably general, and is probably intended, with the hamular fasciculi, for the common purpose of associating together in action the convolutions of the great divisions of either hemisphere.

The inner wall of the capsule is composed of the outer surface of the fibrous cone. The substance contained in this capsule is the outer portion of the

corpus striatum, the inner part of which projects uncovered into the lateral ventricle. The outer portion has a broad inferior surface; above, a sharp falciform margin: before, its extremity is obtuse; behind, pointed; its breadth anteriorly, where greatest, is about an inch; its length about three inches; its depth an inch and a half: in an horizontal section its form appears elliptical: its anterior extremity joins the internal portion before the foremost fasciculus of the fibrous cone; its upper margin is parallel to that of the inner portion, but about two lines lower in the brain; its posterior extremity occurs about two lines before that of the thalamus. Every where but at its fore part it is shut in by its walls. Anteriorly it is perforated by the anterior commissure; gives support to the commissura tractuum opticorum; is continuous with the infundibulum; and, being prolonged, surrounds the anterior crura of the fornix and the corpora albicantia; overlays the walls of the third ventricle, and unites the thalami, under the form of the commissura mollis. It is a question whether this part has not an epithelium as well as the inner portion: but, it may be remarked, that it peels smoothly from the floor and outer walls of its capsule.

When layer after layer is raised from the outer wall of the capsule, an appearance is met with as if fibres radiated from the upper margin of the gray matter. It would seem, that medullary fibres arise from the whole gray substance, the direction of which is towards its upper margin, where they plunge into

the substance of the inner and outer walls of the capsule. On separating the outer portion of the corpus striatum from the inner wall, a similar appearance is met with; and, in addition, exceedingly fine fibrils seem to be derived from the fibrous cone, and to enter the gray matter. It is possible, at least sometimes it has appeared to me, that fine medullary fibres are derived from the outer wall likewise, and enter the gray substance.

The corpus striatum receives its blood-vessels below through the lamina cribrosa; above through the pecten. With its developement that of the other parts of the brain is in some measure proportionate. It is the centre of the hemisphere, and this region is remarkable as the seat of the greatest deviations from the natural state in idiotcy and other mental affections.

Explanation of the Tenth Plate.

A. B. C. D. Margin of the three lobes of the brain. The island has been removed, and the adjoining convolutions rent in their axes. The outer wall of the capsule is exposed.

a. a. a. a. Rent surfaces of convolutions.

b. Hamular fasciculi.

c. d. e. f. Their radiation towards the different parts of the brain.

g. Outer wall of the capsule.

Of the Medulla Oblongata, and of the superior, lateral, and inferior Crura of the Cerebellum, by Professor Reil. Archiven für die Physiologie. Neunter band, p. 485—524.

XII.

Of the Medulla Oblongata, and the Floor of the Fourth Ventricle.

It is difficult to define the exact point, at which the medulla spinalis ends and the medulla oblongata begins; as the latter approaches the former, it gradually assumes a similar structure with it. The medulla oblongata consists, on the fore part, of the pyramids, of two considerable medullary processes, external to these, one on either side, to which the corpora olivaria belong, of the corpora restiformia, and, finally, of two slender chords which are in apposition at the median plane behind.

The pyramids are the most distinctly fasciculated among the parts of the medulla oblongata: in their course downwards they become narrower, and, finally, dip inwards from the surface to their decussation, which takes place in the central gray matter. It is not known whether they arise at this point, or are continued downwards into the substance of the medulla spinalis. In

their ascent they make a distinct channel in the corpora olivaria, and are internally in mutual contact: towards the posterior margin of the annular protuberance, they separate from each other and from the adjoining bodies, and plunge, as separate cylinders, into that substance: all their fasciculi, however, do not appear to pass through the annular protuberance; some ascend behind it, and join with those of the fillet. To understand the interweaving which takes place at a right angle between the fibres of the pyramids and those of the lateral peduncles of the cerebellum, it may be convenient to divide through the calamus scriptorius, and in the median plane, the medulla oblongata and the annular protuberance, as far as to the under layer of the latter. From the rent surfaces the different layers may be readily raised. The annular protuberance is formed by the interweaving of the lateral peduncles of the cerebellum with the fasciculi of the pyramids, and all the other portions of the medulla oblongata, as well as the remaining peduncles of the cerebellum, are placed behind this mass. The corpora olivaria, on the removal of the pyramids, are somewhat cordiform; they resemble the ciliary bodies, and are connected with the grey matter of either half of the medulla oblongata in a manner analogous to the connection of the corpora geniculata with the thalami. The portions of the medulla oblongata, of which these bodies form a part, may be traced downwards as far as the decussation of the pyramids, and upwards behind the corpora olivaria to constitute part of the cylinder of

either crus cerebri. Sometimes a fasciculus, derived from the lower part of the pyramid, passes round the outer margin of the corpora olivaria, and then rejoins the pyramid. The third pair of eminences are the posterior peduncles of the cerebellum; the fourth and slightest are in contact for some extent, but afterwards are inclined away from each other to expose the lozenge-shaped field of the fourth ventricle; they are enlarged at the angle where the divergence begins.

The lozenge-shaped field thus angularly commencing below, contracts above, to a point at which the aqueduct of Sylvius or iter ad quartum ventriculum opens; its margins are made out by the peduncles of the cerebellum. It contains, as in a basin, grey matter, derived from that in the spinal chord, only broader, and proportionate to the increase of white matter. Gray matter ascends uninterruptedly in the axis of the nervous system, chord-like below, a chain of ganglions above, the tubercula quadrigemina, the thalami, the corpora striata.

The gray substance of the lozenge resembles that of the tubercula and thalami; it is paler and firmer than that of the corpus striatum, and is disposed in fibres, which run parallel with its median furrow, the calamus scriptorius. Where the lateral and posterior peduncles of the cerebellum meet at the broadest part of the lozenge, the small triangular chamber exists, into the gray substance contained in which the roots of the portio dura and of the fifth sink, and perhaps those of the eighth: whether they go beyond it is pro-

blematical. To me it seems that the origins of nerves are uniformly in gray matter; that the optic nerve rises from the corpus geniculatum, the third from the black matter, the fifth, seventh, and eighth, from the chamber just described, and the spinal nerves from the gray matter in the axis of the spinal chord.

Two cylindrical fasciculi ascend from as low down as the crossing of the pyramids, one on either side of the central groove of the lozenge: these are half medullary, and simply covered with epithelium; they are broadest in the centre of the lozenge, and are contracted below as well as above, where they join the thalami above the ansa of the anterior peduncles of the cerebellum.

One other layer, the vertical fasciculi, composed not of nervous matter alone, but of cellular membrane likewise, and vessels in unusual proportion, as may be conjectured from its toughness, extends from behind the pyramids, behind the upper transverse fibres of the annular protuberance, and below the ansa of the anterior peduncles of the cerebellum, to the gray substance which is found between the crura cerebri, extending beyond the corpora albicantia, thus building the floor of the third ventricle, and becoming continuous with the infundibulum. The fibres of this stratum seem in some degree to decussate each other.

XIII.

Of the inferior Peduncles of the Cerebellum.

The lobes and lobules of the cerebellum are placed upon a nucleus, which has been described as formed of an extension of its peduncles, and contains the ciliary bodies. Of these peduncles, the lateral alone are confined to the cerebellum; each of these meets its fellow anteriorly in the annular protuberance, behind, in the vermiform processes. The lateral peduncles are the largest, and are cylindrical; the inferior are cylindrical, but of less magnitude; the superior are broad and flattened.

The inferior peduncles, viewed as parts of the medulla oblongata, are distinguished by a more remarkable line of separation from the corpora olivaria than from the fasciculi behind them. Between the three substances just mentioned, the chords of gray matter derived from either half of the spinal chord emerge upon the lozenge-shaped field. Where the inferior peduncles bend away from the medulla oblongata to join the cerebellum, they are in form oval, being flattened before and behind. At this part the principal root of the flock passes round the inferior peduncle in its course to reach the external margin of the superior peduncle; and the surface is overlaid

with the root of the auditory nerve, and the transverse medullary fibres of the calamus scriptorius.

At the outer margin of the superior peduncle an oblong elevation exists, which forms the outer wall of the nidus, and is generally taken for the inferior peduncle. Now if the stem of the flock be removed which passes over this surface, the true course of the inferior peduncle may be seen, and the elevation in question is found to be continuous with the medulla of the lateral peduncle. On raising this external medullary layer the prominence will be found to result from and to have contained a portion of the ciliary body. The inferior peduncle now passes between the superior and lateral peduncles; with the lateral peduncle throws itself over the root of the superior peduncle and of the adjoining velum, and then passes to unite with its fellow in the superior vermiform process. As a line of distinction between the lateral and inferior peduncles, an angle of the chamber before alluded to is continued some little way in their interval. From the trunk of the inferior peduncle its medullary fibres pass backward, the upper fasciculi form the roof of the capsule of the corpus ciliare, the lower pass in part below it.

The corpus ciliare in either hemisphere may be described as inclosed in a capsule formed by the fasciculi of the peduncles, which surround it. In form it is flattened and triangular, with blunted corners, of which one looks forwards towards the prominence above described; its base is turned towards the

posterior lobe. The outside of the capsule is bounded by the lateral peduncle, the inside borders on the vermiform process, the roof is formed by the posterior peduncle, the floor by the superior and some fasciculi of the inferior. The corpus ciliare is easily raised from this capsule. It allows of being unfolded into lobules which seem directed from before backward. Probably many fasciculi from the anterior peduncle pass into this substance, and lose themselves there. Its substance is permeated by many vessels accompanied probably with pia mater. Some of these vessels enter by a cribriform surface between the superior peduncle and the roller-like eminence of the lateral peduncle *. To these vessels may be ascribed the arborescent tubes which extend from before backwards in the ciliary body †.

In preparing a cerebellum for exhibiting the pre-

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* Laminæ cribrosæ are found besides between the crura cerebri and the fillets, round the corpora geniculata interna, between the corpora albicantia, crura cerebri, and anterior margin of the annular protuberance, and in the fossa on the outside of the corpora olivaria.

† The blood-vessels below the tænia semicircularis geminum lie in channels which have red walls, probably from the transudation of the blood. To the same cause may be, perhaps, attributed the occasional red colour of the gray substance, as in the thalami, when the alkohol has not thoroughly penetrated it.

ceding circumstances, the square lobe is to be broken off, the anterior peduncle largely exposed by pressing aside the other two peduncles, which cross over it. The biventral and thin lobes are then to be removed, the almond-like lobes broken off from their stems, the flocks raised from without inwards, and the roots of the auditory nerves peeled back from the inferior peduncles: it only remains to follow the course of the several peduncles now distinctly entering the cerebellum, and finally to raise the corpus ciliare with care from its capsule.

XIV.

Of the lateral Peduncles.

THE lateral peduncles, with their continuations, form a ring encircling the other parts of the cerebellum. This ring is completed on the fore part by the annular protuberance, in which the substance of the peduncles is spread out in strong and coarse fasciculi, so disposed as not to preserve an uniform distance from the surface, but now to approach it, now to recede from it, and in parts to cross each other. The upper and posterior surface of the annular protuberance, stripped of the layers which otherwise cover it, is found to be convex, from above downwards; and the superincumbent mass is proportionately thinner at its centre. The intervals between the transverse fasciculi of the lateral peduncles, and the

ascending fibres of the pyramids, which are interwoven with them at right angles, are filled with gray substance; the latter seems to have more to do with the cross fibres than with those of the pyramids, and is the principal channel of the blood-vessels. Some long fasciculi, derived from the pyramids, ascend above the hindmost transverse fibres to join the fillets: on this account the upper layer of the annular protuberance may be described as composed of longitudinal fibres. After the first layer of cross fibres, which is of tolerable thickness, a broad set of longitudinal fasciculi follow; then transverse, then longitudinal fasciculi; again transverse, and again longitudinal fasciculi, which last are supported on the thickest and convex stratum of transverse fibres, which form the under surface of the annular protuberance. The longitudinal fasciculi, which are nearest to the median plane, are likewise nearest to the under surface, and pursue a straight course with the pyramids: those which occur next are nearer the upper surface, and are inclined outwards from the pyramids. Just in the median plane, transverse fibres and gray substance alone are found. Whether any connection exist between the two sets of fibres above described is uncertain. A blind depression, out of which the third nerves seem to emerge, exists between the crura cerebri and the anterior and upper margin of the annular protuberance: a similar pit exists at the lower margin of the latter. Where the fasciculi of the crura cerebri join the annular protuberance, their margins are reciprocally indented.

The lateral peduncles, followed backward along the horizontal fissure, internally divide into an upper and an under layer, the fibres of which in part pass inwards towards the vermiform processes, in part radiate backwards to be distributed to the posterior lobes of the cerebellum. On this account rents of these lobes break deep into the substance of the lateral peduncles, whereas the upper and under lobes break superficially off, leaving ridges upon the surface of the peduncle. The fasciculation of the peduncle is finer when within the cerebellum: very likely there is no substance intermediate between the peduncle and the lobes. Under the anterior and external angle of the square lobe a centre exists, whence the fasciculi of the peduncle spread out, and in a curvilinear direction, tend towards the vermiform processes. Upon the under surface the flock must be taken off, to show the apposition of the lateral to the superior peduncle. The former throws a circular layer round the bend of the inferior peduncle to join the superior; this contains the projecting outer margin of the anterior extremity of the ciliary body. The lateral and inferior peduncles throw themselves inwards over the superior, to unite with their fellows in the superior vermiform process. Below, the lateral peduncle adheres to the flock, which is inclined round the nidus, to reach the stem of the pyramid: then follow the stems of the biventral and slender lobes; and the remaining portion of the lateral peduncle radiates into the under and posterior lobe.

In preparing a cerebellum for the demonstration of this part, the square lobe must be broken away, above; the flocks with their stems, the biventral, and the slender lobes, below; the almond-like lobes must be drawn off from their stems in a direction from below upwards; the posterior crura fairly exposed at their bend, and the apex of the ciliary body denuded.

XV.

Of the superior Peduncles, the anterior Medullary Velum, and the Fillets.

Either fillet may be traced as far as the inferior margin of the annular protuberance: at this point it lies betwixt the pyramids and the upper margin of the corpus olivare, and is continuous with that layer of the former which passes behind the superior transverse fibres of the annular protuberance, and with the fasciculi derived from the summit of the latter. Inwards, the fillet is bounded by the vertical fasciculi already described as continued to the infundibulum: outwards, it extends to the point at which the fifth and seventh nerves dip in. Just before it reaches this level, the fillet divides; one part is directed forwards, immediately above the fibres of the pyramid, and passes below the black substance; the other, having passed below the roots of the fifth and seventh nerves, then strikes upwards, and emerges between the anterior

and lateral peduncles of the cerebellum, and the crura cerebri; is then obliquely bent over the superior peduncle, at the outside of the inferior tubercle. This portion, again, of the fillet divides: one part, the external, attaches itself to the column of fasciculi which ascends behind the annular protuberance, and passing below the corpus geniculatum, joins apparently the fibrous cone. The internal part inclines inwards, and expands below the tubercula, principally the superior, so as to join its fellow of the opposite side in the median plane. This inner subdivision of the fillet forms the roof of the iter ad quartum ventriculum; and its upper central fibres are seen through their epithelium, at the interval between the superior tubercles. The transverse medullary fibres of the posterior commissure are, like the preceding, continuations of this inner subdivision of the fillet. On raising the convex surfaces of the tubercula, and following this process of the fillet, a gray and vascular prominence is found, corresponding with each inferior tubercle, disposed transversely, having an obtuse termination outwards, and narrowing inwards. At the inferior margin of each prominence, fibres of the fillet pass across; perhaps they penetrate below it likewise.

The fasciculi of the fillet are parallel to its course. The anterior peduncle of the cerebellum is so slightly attached to it, that, on the removal of the epithelium, a probe may readily be passed between the two former substances.

For the demonstration of this part, a half-hardened

brain is to be selected, and the epithelium removed from the fillet, and from the anterior peduncle of the cerebellum. The fillet is then to be followed in its upward course; the convex surfaces of the tubercula raised from it, as far as the median plane; and thus the inner subdivision exposed. In following the outer portion, it is necessary to raise the tractus opticus, with its ganglion, and then the posterior margin of the thalamus. In tracing the fillet downwards, the lateral peduncle of the cerebellum is to be pressed away from it to some depth; a rent then carried along the calamus scriptorius through to the upper transverse fibres of the annular protuberance; and the mass of longitudinal fasciculi behind them raised from within outwards; between which and the transverse fibres the fillet descends. Lastly, the fillet may be cut across, and its anterior surface exposed.

The anterior peduncles of the cerebellum are flat, and most resemble in structure the fillets, or the fornix. Like the former, they extend between portions of gray matter, viz. between the gray matter of the ciliary body and the cylinder of the crus; as the fillets extend between the thalami and the cylinders. Like the fornix, their fibres are flax-like, delicate, and distinct; they decussate each other laterally, and thus doubly unite the cerebrum and cerebellum. The general direction of their fibres is longitudinal.

It may be convenient to divide each of them into a body and two extremities: the body, or exposed part, is entirely covered with epithelium, and in addition,

with a thin layer of gray matter on its under surface. Between the bodies of either is expanded the anterior medullary velum; a substance consisting of fibres, which run parallel with those of the anterior peduncles, and finally pass between the upper and under vermiform processes to complete their nucleus. Either surface of the velum is covered with epithelium. The upper surface is sometimes, at an early period, medullary; but is, in most instances, covered with a transversely furrowed layer of gray matter. In the latter case the first lobule of the superior vermiform process is either wholly continuous with the velum, or its base alone, or, perhaps, merely its margins, by which means a canal is enclosed, running backwards between the velum and this lobule*. A small process extends some way upon the velum, derived from the centre of the posterior tubercles. In the sheep's brain, a packet of fibres passes from one peduncle to the opposite, immediately behind the tubercles; and another cross band is formed at the further margin by the anterior and posterior peduncles together; whence results an oval, in which the anterior velum is expanded. In the human brain more or less of the same structure exists: there, too, fasciculi, derived from the entire nucleus of the cerebellum, pass forward and upward in the form of anterior peduncles and medullary velum,

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* Malacarne, Nuova Exposizione della vera Struttura del Cerveletto Umano. Torino, 1776. p. 108.

enter the cylinder of the crus cerebri, on either side of the aqueduct of Sylvius, and below it blend together.

The anterior extremity of the peduncle crosses below the fillet, inclines rather downwards and inwards, forms the anterior margin of the lozenge-like field, completing, in connection with its body and the medullary velum, the sloping roof of the fourth ventricle. In the angle at which the roof meets the inclined floor of the ventricle, a stripe of black matter is seen through the epithelium covering it. Here, and in the crus cerebri alone, before the annular protuberance, black matter is met with; and at both points it seems to belong to the superior peduncles of the cerebellum: sometimes the black matter is wanting, and in its place the nervous matter is stained red with blood. From the median furrow of the lozenge, delicate medullary fasciculi emerge, which run obliquely above the ascending processes formerly described, above the black substance again, and attach themselves to the inner margin of the superior peduncles.

The peduncles now plunge downwards, forwards, and inwards, into the cylinder, having, above, the tubercula quadrigemina, above and without, the fillets, within, the vertical fasciculi: below the latter they unite by means of an ansa, which is several lines in thickness, and forms the upper wall of the foramen cæcum: it is a question whether a complete continuity or anastomosis occurs here. Above this ansa

then, as has been already mentioned, is the course of the cylindrical fasciculi: below it, that of the vertical fasciculi; some of the component fibres of the cylinder pass right through the substance of the anterior peduncles. The anterior peduncles finally radiate forward, and surround a mass of gray substance in the inner and posterior part of the thalamus, which lies before the ansa, and behind the root of the fornix.

The posterior extremity of either superior peduncle extends below the roller-like substance into an hemisphere of the cerebellum. It has sometimes appeared to me, particularly in the brains of sheep, that from the chamber formerly alluded to a process passes below the inferior peduncle to unite with the superior just before it disappears from the surface. Along the depressed line, where the superior peduncle and roller-like substance meet, a lamina cribrosa occurs, through which vessels pass to the ciliary body: the inner margin of the anterior extremity of the ciliary body peeps out at this interval likewise. The superior peduncle, which is contracted at the point where it disappears, now extends directly backwards; laterally it spreads itself, and divides into packets; appears to enclose some portions of the ciliary body, to penetrate, and even to terminate in them. The greater part of the ciliary body lies, however, above the superior peduncle, the outer and anterior prominence alone being fairly below it. On the whole, the connection of the superior and inferior peduncles with the ciliary body,

and the manner, in which the superior peduncles terminate, is so confused and intricate, that I cannot venture to speak positively respecting its structure. Some elucidation of these points may be hoped from successful injections of the part.

In preparing for a demonstration of these circumstances, it is convenient to break away the square lobes from the cerebellum ; to strip the fillets, and the bodies of the superior peduncles, of epithelium ; to divide the vermiform processes in the median plane; to raise the roller-like substance from the superior peduncles, and to turn aside the inferior and lateral peduncles, with the ciliary bodies adhering to them. Then the caps of the tubercula quadrigemina may be pressed off, to expose the radiation of either fillet, the fillet itself raised from the outer surface of the superior peduncle, the inner surface of which is to be denuded, and the aqueduct of Sylvius laid open, to show the ansa. The cylindrical fasciculi may finally be raised, and either superior peduncle itself turned forward, that its inferior surface may be seen.

XVI.

Of the Tubercula Quadrigemina, and Thalami.

As the dissection of the brain proceeds, these bodies lose their character of distinct organs. The tubercula quadrigemina have four round caps of gray matter,

which are placed on the radiation of the fillet: before and behind the four tubercles, and below the anterior pair, that radiation may be traced; on the one hand including the posterior commissure, on the other, fibres, which pass to the frænulum. The substance of the posterior tubercles extends the deepest; so that these remain, after the exposure of the radiation of the fillet.

Laterally the tubercles are covered by the posterior extremity of the thalami, and they have processes which plunge anteriorly and laterally into those bodies. The fillet ascends underneath the process of the posterior tubercle; then underneath the corpus geniculatum it extends into the thalamus, expands, and blends with the production of the corpus geniculatum and the fillet: the three substances together pass on to join the fibrous cone. Yet, must it not be expected, that in the tubercula, and still less in the thalami, the different layers lie distinct: they are rather fused, and blended in one mass. From the processes of the posterior tubercles, fibres seem to proceed, in a curvilinear direction, over the corpora geniculata to the posterior margins of the thalami.

The transverse fibres of the posterior commissure are individually distinct behind; but apparently, on the fore part, connected into one bundle by epithelium. Above it is placed the pineal gland, connected by four peduncles to its anterior and posterior surfaces. The posterior commissure is prolonged in a medullary band along the upper and inner margin of

the thalami. Another process of the posterior commissure passes transversely across the lateral processes of the anterior tubercles; and a third seems to descend vertically in the thalamus to the anterior and outer margin of the same. At least, I have often found a delicate nerve, of the thickness of an horsehair, taking this course.

At the floor of the aquæductus Sylvii the cylindrical fasciculi are placed; below these, the ansa of the anterior peduncles of the cerebellum; and then the remaining mass of the crus cerebri.

The thalami have each a cap, which is superficially covered with medulla, and may be pressed off from the upper margin of the wall of the third ventricle, and from the corpora geniculata; behind, where it is of somewhat less breadth, it divides into two projections. The posterior obtuse projection, which is fully seen on the removal of the tractus opticus, and lies immediately below its ganglion, forms, in common with the tænia semicircularis and some fibres of the corpus callosum, the tapetum of the inferior horn, and blends with the radiation of the fibrous cone and anterior commissure. The other inclines round the crus cerebri, and is prolonged into the tractus opticus.

The tractus optici arise in part from thin medullary plates, which cover the surface of the thalami, in part by roots, which emerge below the inferior margin of the thalamus, and partly by medullary fibres derived from the corpus geniculatum internum: upon either tractus is found a corpus geniculatum externum. The

under surface and concave margin of the tractus are unattached; the upper surface is attached by membrane to the crus cerebri, and the outer margin seems to cohere with the gray substance of the corpus striatum, and to have vessels which pass above and below the medulla incognita, with something of the disposition of meseraic vessels. Their commissure adheres above to a layer of gray substance, which extends to the infundibulum from the floor of the third ventricle. In the caps of the thalami, the roots of the anterior crura of the fornix arise.

The substance below these caps blends with the processes of the tubercula quadrigemina, with the radiation of the corpora geniculata, and with that of the superior peduncles of the cerebellum. Before the ansa of the latter, the gray mass already spoken of at the back part of either thalamus is found. The corpora geniculata of the thalami are globular, and gray behind, anteriorly medullary, and expand themselves over the crura cerebri, especially along their outer margin. At the outer margin of the thalami these various structures blend in the pecten, which is thus a texture woven of the crura cerebri and thalami. The inner surfaces of the latter are united by the commissura mollis, and by the substance of the floor of the third ventricle, which extends from the infundibulum to the aquæductus Sylvii.

Explanation of the Eleventh Plate.

In preparing for this demonstration, the greater part of the hemispheres of the cerebrum may be removed, care being taken to leave the corpora striata and optic thalami uninjured. It will be better to begin with cutting the corpus callosum through longitudinally as far as its anterior fold, leaving the latter entire to assist in holding together the corpora striata on the forepart.

a. a. The posterior margin of the hemispheres of the cerebellum, consisting internally of the under and posterior, externally of the upper and posterior lobe.

b. The posterior, or purse-like fissure, in which the last lobule of the superior vermiform process remains unremoved.

c. The lateral peduncle of the right side of the cerebellum exposed by the removal of nearly the whole of the square lobe: the coarse ridges, with which the lobules of the latter were articulated, are seen to pass from the peduncle, in a curvilinear and somewhat divergent course towards the superior vermiform process.

d. A small portion of the square lobe unremoved.

e. The right anterior peduncle of the cerebellum, covered with its epithelium, and emerging from below the lateral peduncle.

f. The fillet on the right side, which dips in between the anterior and lateral peduncles of the cerebellum and the crus cerebri, to reach the floor of the fourth ventricle.

g. The crus cerebri, and its denticulation with the lateral peduncle of the cerebellum, or with the anterior margin of the annular protuberance. This appearance is better seen on the opposite side.

h. A portion of the corpus callosum pressed aside. The tail-like prolongation of the inner part of the corpus striatum is broken off, so as to expose the decussation of the fibres of the two systems of the nucleus at this point.

i. i. The tubercula quadrigemina of the right side,

k. The corpus geniculatum internum. Above this the processes of the upper, and below the processes of the under tubercula enter the thalamus.

l. The thalamus nervi optici of the right side.

m. The anterior obtuse extremity of the inner portion of the corpus striatum: its inner margin is with the tænia pressed aside.

n. The concave surface of the anterior fold of the corpus callosum. The epithelium is removed, excepting near the crura of the fornix.

o. A section of the anterior crura of the fornix, between which the central part of the anterior commissure is seen.

p. The medullary nucleus of the vermiform processes, which, with the anterior medullary velum, is interposed between the anterior peduncles of the cerebellum: its fibres are disposed like those of the adjoining parts.

q. The anterior medullary velum, stripped of its epithelium and grey surface; at its junction with the nucleus it is narrowed. The right half of the frænu-

lum of the tubercula quadrigemina is left attached to it.

r. r. The left superior peduncle of the cerebellum, appearing from below the fillet: it is slightly contracted, where the lateral and inferior peduncles cross it: in its progress backward it partly perforates the corpus ciliare, and in part passes below it; as the inferior above it.

s. The inferior peduncle of the cerebellum detached and thrown outwards: it is seen to emerge from between the lateral and superior peduncles.

t. The lateral peduncle: where it joins the former, a small chamber is left filled with gray matter, from the lozenge-shaped floor of the fourth ventricle, in which the roots of the fifth and seventh nerves are found.

u. The crus cerebri.

v. w. x. y. The fillet. *v.* Its fasciculi emerging between the peduncles of the cerebellum and the crus cerebri, pursuing, on the whole, a direction similar to the latter. *w.* That portion of its fasciculi, which passes below the tubercula quadrigemina to become continuous with the corresponding portion of the opposite fillet: at the same time the epithelium is removed from the inferior tubercle of the left side, which consists of a nodule of gray matter united to its fellow by medullary fibres: a few fibres of the fillet are seen to pass below this body to the frænulum. Between the anterior pair of tubercles is a triangular surface, occupied likewise by fibres of the fillet, passing towards the median plane, which are seen indi-

stinctly through their epithelium. Above these is the posterior commissure, which, when seen from behind, is transversely fasciculated. The pineal gland is here removed.

x. y. The expansion of the fillet in the thalamus, the globular upper part of which has been broken off, from within outwards: these fibres of the fillet blend with the mass of the thalamus. *y.* Section of the root of the anterior crus of the fornix.

Of the anterior Commissure in the Brain, by Professor Reil. Archiven für die Physiologie. Eilfter band, p. 89—100.

XVII.

THE anterior commissure may be divided into a body and two extremities. The body is cylindrical, and at least twice as large as an optic nerve; but its bulk varies, like that of all the parts in the brain which resemble nerves. The anterior commissure consists of fasciculi, of the finest fibrils, which admit of ready separation, when the delicate membrane which invests each and all is divided. The cellular sheath of the commissure seems derived from the floor of the third ventricle, and is not dispensed with till the radiated disposition of the extremities of the commissure begins.

The anterior commissure extends transversely across the brain, from the middle lobe of the one side to that of the opposite. The central part, corresponding with the interval between the anterior crura of the fornix, is unattached behind: to its anterior and convex margin the septum lucidum is affixed: before it the fillet of the lamina cribrosa ascends to reach the septum: the fillet of the one side is united to its fellow by a delicate membrane, which lies before the anterior

commissure, and adheres to the upper margin of the commissura tractuum opticorum. Between the fillets of the lamina cribrosa and the crura of the fornix the anterior commissure extends on either side, through an oval hole, into the corpus striatum: its course is by the anterior extremity of the thalamus, between this and the posterior margin of the inner portion of corpus striatum, and along the neck between both, in which the tænia inclines downwards.

Centrally the anterior commissure is raised a little, and somewhat inclined backwards; then plunging laterally into the gray mass of the inner part of the corpus striatum, it passes close below the first fasciculus of the fibrous cone, or even sometimes is enclosed between its foremost fasciculi. In its course through the outer portion of the corpus striatum it lies about three to four lines above the lamina cribrosa, is extended horizontally in a curvilinear direction, concentric with that of the tractus opticus, then is inclined somewhat downward towards the base of the middle lobe, then is directed backwards below the posterior extremity of the hamular fasciculi in the entrance of the fissura Sylvii, to the point whence its extremity radiates: when raised, it leaves for this extent a distinct and smooth canal.

The divergent fibres of the commissure are attached to the inner surface of the hamular fasciculi, pass with these to the roof of the inferior horn, and even to the posterior lobe, blending with the general radiation in these parts. Blood-vessels perforate the lamina cribrosa

in the course of the anterior commissure, and encircle its body, particularly near where the divergence of its fibres begins.

In sheep, the anterior commissure, as if composed of two cylinders in apposition, divides at either end into an anterior and posterior branch: the anterior branch bends itself forward at the foremost fasciculus of the fibrous cone towards the processus mammillaris and its outer wall, and is lost where the latter meets by a narrow opening the anterior horn, in radiated fibres which surround this opening. The posterior branch, on either side, is much thinner, and passes along the isthmus between the corpora striata and thalami in which the tænia lies: in the hare a similar organization is seen.

In preparing these parts for demonstration, the hemispheres are to be cut away above the corpus callosum, the brain hardened, and the hamular fasciculi in the fissure of Sylvius carefully exposed. The brain being then reversed, the floor of the inferior horn is to be removed, the hamular fasciculi to be transversely divided in their middle, and the posterior half drawn towards the middle lobe, by which means the point at the under surface of the corpus striatum is brought into view, from whence the commissure issues, and its exposure in either direction may be completed.

I have recently employed upon separate portions of brain the following mode of preparation, which facilitates greatly the separation of its fibres. Portions of brain are to be placed in oil of turpentine, ma-

cerated for from four to six days, and subsequently hardened in alkohol. The turpentine is frequently to be changed on the portions of brain, which should be kept in a cool place.

Explanation of the Twelfth Plate.

THE fissura Sylvii having been treated as for Plate X., the outer wall of the capsule is peeled from the outer portion of the corpus striatum. The upper margin of the latter is semicircular, or nearly so; the under margin nearly straight, but lower before than behind; its outer and under surface are somewhat convex; its thickness is greatest below, whence it continually narrows towards its upper, sharp, and curvilinear margin. The outer wall of the capsule decussates at this margin the inner wall formed by the fibrous cone. The hamular fasciculi are cut through in their middle, and the posterior half drawn off towards the middle lobe. At the upper part, fasciculi are seen belonging again to the intermediate and connecting stratum. Their disposition is extremely intricate; they form a mass less white, and exhibiting more vascular pores than the medulla of the convolutions which rest upon them.

a. b. c. The margin of the hemisphere.

d. The anterior part of the hamular fasciculi, which pass to the anterior lobe.

e. The body of the anterior commissure emerging from the outer portion of the corpus striatum, inclining backwards, ending in divergent fasciculi, which blend with the radiation of the outer and inner walls of the capsule.

f. The intermediate layer of medullary fasciculi which seem interposed between the convolutions and nucleus of the cerebrum.

g. A portion of the outer wall of the capsule left attached, and so lifted as to show the decussation of its fibres with those of the inner wall.

Of the Septum Lucidum, the Fornix, and the Ventricles of the Brain, by Professor Reil. Archiven für die Physiologie. Eilfter band, p. 101—116.

XVIII

Of the Septum Lucidum and its Ventricle.

The septum lucidum is interposed like a mediastinum between the lateral ventricles, and in a similar manner is formed by the reflection of two layers of the lining membrane (in this case the epithelium), one derived from either cavity, which it assists in separating. The septum has an ill-defined, triangular margin, bounded by curved lines; its inferior angle reaches to the anterior commissure, where it lies exposed between the anterior crura of the fornix and the fillets of the lamina cribrosa; its apex is found between the fornix and the corpus callosum, in the vicinity of the lyra; its third and rounded angle at the concave surface of the anterior fold of the corpus callosum. The base of this triangle is short; the under concave and the upper convex margin of the septum form the longest sides. At the fore part the septum begins by the meeting of either layer of epithelium upon the anterior

commissure; and the base of the triangle, above supposed, is formed by an extension of the septum from this point to the bend of the corpus callosum, and corresponds with a linear furrow, which is seen on the base of the brain between the fillets of the lamina cribrosa. From the posterior extremity of this furrow, which immediately touches the anterior commissure, a delicate membrane extends to the commissura tractuum opticorum, and thus is the base of the brain completed anteriorly. Again, from this linear furrow, the duplicature of the septum may be unfolded, and the division of the brain into two similar lateral portions effected.

Between the layers of the septum a shut ventricle, clothed with a proper epithelium, exists. This ventricle is from a line to a line and a half in breadth at its fore part, where it extends between either surface of the reflected fold of the corpus callosum: thence it becomes narrower backward, and ends in a point above the lyra. The septum contains, within its double layer of epithelium, fibres derived from the fillets of the lamina cribrosa, and from the upper surface of the fornix.

XIX.

Of the Fornix.

The root of either anterior crus begins in either thalamus, between its superficial plates, about a line below its upper surface, under a distinct eminence at its fore part near the tænia: the root descends, being first inclined backwards, then forwards abut opposite to the lower margin of the commissura mollis, splits into two or three fasciculi, and emerging upon the under surface of the brain, forms, by its reflection, the corpus albicans. This substance contains gray matter; the chord prolonged from it, and termed the anterior crus, ascends before the thalamus, and derives, from the medullary border of its inner and upper margin, a slender fasciculus at a point over against the anterior commissure; otherwise the concave edge of the crus is unattached. The convex side is in adhesion with the septum lucidum, and gives to that body slender fasciculi joining those of the fillet.

Above the anterior commissure either crus of the fornix, before cylindrical and apart, becomes flattened and in apposition with its fellow; and thus the body of the fornix begins, which is extended directly backward, and terminates, where the lateral portions, yet further flattened, diverge, and become posterior crura. The inner margins of the lateral portions of the fornix

behind adhere to the corpus callosum, and thus close the pointed extremity of the ventricle of the septum lucidum: the outer unattached margins slope downwards. The lyra is the surface which begins at the divergence of the posterior crura: in most instances it seems to be but the extremity of the posterior fold of the corpus callosum, and not to derive fibres from the inner margins of the posterior crura of the fornix. A process of the posterior crus extends backward between the layers derived from the upper and under parts of the posterior fold, to lose itself in the convolutions of the posterior lobe of the brain.

The posterior crus of the fornix, in connection with fasciculi from the posterior fold of the corpus callosum, finally extends towards the middle lobe, to form, with the long internal convolution, the hippocampus major. The fasciculi from the fornix form in part the covering of the hippocampus; in part, its loose fold, the tænia hippocampi. These fasciculi are very delicate, and have a direction from within outward. The gray substance of the hippocampus appears first as a narrow layer upon the posterior fold of the corpus callosum. Where it lies as indented border between the tænia hippocampi and the long convolution, with the latter of which it has no direct continuation, its surface is transversely furrowed, and partly cribriform; it terminates by several processes in the pes hippocampi.

In some animals the fornix is developed inversely as the other parts of the brain. The fornix extends from the gray matter of the thalami to that contained in the

hippocampus. It is composed of delicate, and intricately woven, flax-like fibrils. In each lateral portion a central vessel is found, and, at its margin, the gill-like flexus choroïdes. The fornix unites remote parts in the length, the anterior commissure in the breadth of the brain. Like these, the corpus callosum involves no gray matter, and, with them, perhaps, forms an apparatus for transmission merely.

The brain seems composed of one set of fasciculi which diverge, of another, which converge. Its general form, and that of its parts, is spherical: its interior structure is almost every where fibrous.

XX.

THE ventricles result from the horizontal apposition of the corpus callosum to the ascending and diverging crura cerebri: properly there is but one extensive cavity, which surrounds the thalami, extending (as the third ventricle) below them to the infundibulum, and through the aqueduct to what is termed the fourth; and this is not every where enclosed by cerebral surfaces; but is open below the lyra, and at the lower aperture of the fourth ventricle.

To illustrate the preceding details, a brain should be thus prepared. The two hemispheres should be horizontally removed above the corpus callosum, and the anterior half of the long convolution peeled off. The fore part of the corpus callosum should the be cut

through in the median plane; so as to allow of the exact separation of the layers of the septum lucidum; and the section afterwards carried completely through it. The posterior half of the long convolution is now to be removed, bringing away with it laterally as many adjoining convolutions as may suffice to show the course of the fasciculi, which are derived from the posterior fold of the corpus callosum to the posterior and inferior horns of the lateral venticle: the gray substance may then be removed from the interior of the hippocampus.

Supplement to the Anatomy of the Cerebrum and Cerebellum, by Professor Reil. Archiven für die Physiologie. Eilfter band, p. 345—376.

XXI.

Of the Cerebrum.

THE pyramids, which are the elementary parts of the crura cerebri, become broader in their separate ascent through the annular protuberance, and above this body still enlarging recede from each other. The corpus callosum placed horizontally on their summits encloses with them the general cavity of the cerebral ventricles.

The form of the corpus callosum is well illustrated, by supposing all its parts attracted towards its centre. To exhibit its outer surface completely, a single entire hemisphere, and a brain with the hemispheres cut horizontally off half an inch above its level, are required: from the latter preparation again the long convolution, which contains the covered bands, with these is to be rent off, so as to expose the transverse course of the middle fasciculi, and the radiation of the extreme fasciculi of the corpus callosum.

It may now be seen that the anterior fold of the corpus callosum ends with a distinct concave margin

a full quarter of an inch before the anterior commissure. From this margin a furrow extends backwards, either half of which results from a reflection of the epithelium, which invests the anterior horn of the lateral ventricle, and assists in forming the septum lucidum: a rent from this furrow, therefore, would split the base of the septum. Along either margin of this furrow a white band, continuous with the medulla incognita, is seen to extend to the edge of the anterior fold of the corpus callosum, at which point a blind foramen exists: the two white bands are the fillets of the lamina cribrosa. Medullary fasciculi are generally observed to be derived from them, which in most cases plunge in by the blind foramen, and lose themselves in the septum lucidum; but sometimes are continued along the convex surface of the anterior fold of the corpus callosum to join the linea Lancisii. A thin layer of nervous matter is continued from the furrow and posterior margins of the fillets, to the commissura tractuum opticorum, closing the third ventricle at the fore part. The concave extremity of the anterior fold, the fillets, the lamina cribrosa, and the gray matter of the inner and inferior convolutions of the anterior lobes, are reciprocally continuous. The lateral expansion of the extremity of the anterior fold of the corpus callosum, which extends to join the hamular fasciculi, and to constitute the outer wall of the capsule, is shown by breaking through the furrow between the fillets for the depth of a quarter of an inch, and then carrying the rent horizontally outwards.

When the long convolutions are broken off from an entire brain, the breadth of the corpus callosum appears doubled; the structure ascribed to this body continues unaltered till beyond the outer margin of the covered bands, where the substance of the outer layer of the corpus callosum appears reflected into the medulla of the convolutions, and with the latter peels into plates and fibrils. In quadrupeds, both margins of the corpus callosum are similarly folded: the posterior does not, as in human beings, form a broad layer closely applied to the opposite surface.

The covered bands are lodged in distinct furrows upon the corpus callosum: they terminate anteriorly at the meeting of the fillets of the lamina cribrosa with the anterior fold of the corpus callosum, becoming more delicate as they approach this point, and finally fibrous and reciprocally continuous. On the other hand, turning round the posterior fold within the long convolution, they give off one delicate radiation, which joins and is interwoven with that derived from the posterior fold to the floor of the posterior and inferior horns; their larger portion on either side becoming continuous with the medulla of the extremity of the long convolution now employed in the formation of the hippocampus.

After the preparation of the fissura Sylvii, as already described, if a rent be carried horizontally from the upper surface of the corpus callosum, and in the same manner the course of its deeper fasciculi be traced to the upper margin of the capsule, they are found to become

continuous with the fasciculi of its inner and outer wall. In this way the nucleus of the brain may be stripped of its convolutions.

Between the corpus callosum and convex margin of the inner portion of the corpus striatum, is found the layer of medulla before alluded to, which may be termed the semilunar border [halb-mond-förmiger saum]: its greatest breadth is at its middle, whence it tapers to either pointed extremity. By this mass the fasciculi of the fibrous cone are bound together, upon emerging from the gray portions of the striated body: above it the fasciculi of the fibrous cone and corpus callosum meet, and if a rent be carried directly forward from it to the fore part of the anterior lobe, fasciculi, derived from the anterior fold of the latter, are seen to run forward and parallel and internal to the foremost fasciculi of the cone, in this respect coinciding with the radiation of the posterior fold. The medullary layer at the outer margin of the corpus striatum breaks into curvilinear processes, one lying behind the other. It seems to have no regular structure. In human brains it becomes thinner backwards, and ends towards the posterior margin of either thalamus in a somewhat reticular disposition: in the brains of quadrupeds this substance is more developed posteriorly, and is the source of the tapetum. In the brain of an adult person, the ventricles of which were extraordinarily distended with water, the fasciculi of the corpus callosum and of the fibrous cone were found continuous at the chamber containing the substance now described:

the convolutions were in this instance no ways changed.

It may be remarked that the medullary substance in general is that, to which a definite structure is to be referred, and that the gray matter is rather enclosed in the interstices of the former, or thrown into globular portions, or as a layer upon its surface. The substance, which mechanically connects the remote convolutions in the brain, and is interposed between these and the nucleus, is permeated by more vessels, is softer, and of a browner tint, than the medulla generally. The tænia semicircularis geminum is formed of fibres, which proceed obliquely backwards and outwards from the upper surface of the thalamus, and are strengthened by a fold of epithelium. The tænia is thickened as it passes along the posterior margin of the thalamus, and terminates finally, after having somewhat reticularly invested the inner half of the roof of the inferior horn, in the obtuse extremity of the middle lobe, which adheres to the lamina cribrosa: between the tænia and the tapetum in the inferior horn, the tail-like process of the inner portion of the corpus striatum is prolonged to its extremity, and may with care be raised: here and there its gray substance seems changed for medullary matter, which separates in fibrils or reticular layers.

The gray kernels of the globular portions of the cerebral nucleus require further consideration. Those in the posterior tubercles are well shown in Plate XI, as they are exposed on the removal of the epithelium

and a thin medullary layer; they are about the size of a barley-corn, and lie with their points towards each other.

The bed of gray substance analogous to them in either thalamus occupies its internal and posterior part: from this are derived fasciculi, which partly join the radiation of the fibrous cone, occupying its fore part; but some fasciculi internal to the others, bend round the margin of the crus cerebri, forming the medulla incognita. This substance finally is of peculiar character, neither gray nor white; it adheres to the outer margin of the tractus opticus.

Explanation of Plate XIII.

THE present engraving is an improvement upon Plate IX, to the remarks accompanying which the reader is referred for the method of dissection.

A. A. The anterior,

B. B. The middle,

C. C. The posterior lobes of the brain seen from below, after a section in the median plane, extending to the corpus callosum, and allowing a partial separation of the hemispheres.

D. D. Section of the crura cerebri.

E. E. Surfaces resulting from a longitudinal section of the floor of the posterior horn of the lateral ventricle.

F. F. Meant to represent portions of the walls of the inferior horns turned aside.

G. G. The pes hippocampi on either side.

H. H. The indented border.

a. The extremity of the anterior fold of the corpus callosum, separated laterally from the inner surface of the anterior lobe.

b. b. The lines, along which the covered bands are placed: within these the corpus callosum is composed of flat fasciculi. Externally it rends in foliated plates, which appear continuous with the ordinary structure of the convolutions.

c. c. c. c. Torn surfaces of the inner convolutions of the anterior lobes.

d. The concave margin of the anterior fold of the corpus callosum.

e. The membranous continuation of the anterior fold formed by the epithelium of the anterior horns of the lateral ventricles: on it are seen the fillets of the lamina cribrosa.

f. f. Section of the commissura tractuum opticorum.

g. g. Section of the anterior commissure.

h. h. Section of the commissura mollis, pineal gland, and tubercula.

i. Root of the anterior crus of the fornix, supposed to be seen in its course within the thalamus.

k. Its nodule, or corpus albicans.

l. Anterior crus of the fornix.

m. Fasciculus joining it, derived from the inner and upper margin of the thalamus.

n. Meant to represent the third nerve.

o. Under surface of the corpus callosum, deprived of epithelium.

p. Radiated expansion of the corpus callosum behind the thalamus, below that of the fibrous cone, forming the tapetum, and extending to the extremity of the posterior horn.

q. Radiation of the tænia semicircularis in the inferior horn, forming a tapetum for the inner half of its roof.

r. Radiation of the corpus callosum, forming a tapetum for the outer part of the roof of the inferior horn: between the two, the cauda of the corpus callosum extends.

s. Termination of the tapetum, where the roof and floor of the inferior horn meet. A decussation of its fibres seems to take place with those of the fibrous cone, and of the intermediate connecting stratum.

t. Points, at which fasciculi of the corpus callosum and of the fibrous cone meet, in part uniting with, in part decussating each other.

u. Fasciculi of the corpus callosum, extending into the posterior lobe, with the convolutions in which they appear continuous, as they are parallel to the adjacent fasciculi of the fibrous cone.

v. Central layers of the corpus callosum, in part disposed below, in part becoming continuous with the substance of the fibrous cone.

w. The posterior fold of the corpus callosum, which

is thickest at its middle, and laterally indented by the long convolution.

x. Posterior extremity of the fornix. The inner part is seen to extend backwards above the folded part of the corpus callosum: the outer, which alone properly constitutes the crus, is cut short.

y. *z*. Radiation of the posterior fold of the corpus callosum in the posterior, and towards the inferior horn of the lateral ventricle.

1. 2. Radiation of the fibrous cone.

3. The semilunar border.

4. 4. Line along the posterior margin of the thalamus, at which the fasciculi of the fibrous cone are not covered with a tapetum.

5. Radiation from the posterior extremity of the thalamus, which blends in the inferior horn with that of the fibrous cone.

Plate XIV.

represents the connection between the fasciculi of the corpus callosum and those of the fibrous cone.

a. *a*. *a*. Corpus callosum, with the tapetum derived from it.

b. *b*. *b*. Radiation of the fibrous cone from the outer margin of the thalamus: the foremost fasciculi appear to meet those of the corpus callosum at right angles, the middle fasciculi to become directly continuous

with the latter, and the posterior, to be extended in a separate layer above them.

XXII.

Of the Cerebellum.

THE ciliary body has the appearance of a flattened cone, the truncated apex of which is directed forward, the base backward: it is composed of a plate of gray matter, irregularly crumpled in doubled folds, giving it outwardly the appearance of portions of intestine in parallel apposition. Before its obtuse point, and at the margin where the anterior peduncle disappears, is a cribriform surface for the transmission of its vessels. The anterior peduncles of the cerebellum pass into the ciliary body, between the folds of which and between the fasciculi of the anterior peduncles, tubes are found in the nervous matter, reddened with blood, and directed from before backward, showing the course of blood-vessels. The ciliary body is covered above by the lateral and inferior peduncles of the cerebellum: before and externally, where the outer margin of the inferior velum is attached, its projecting edge is covered by epithelium alone; behind, its shorter process is covered by the stems of the thin lobe, of the biventral lobe, and by the band extending from the root of the almond to the spigot. The ciliary

bodies lie strictly in the hemispheres of the cerebellum, whence it happens that they are wanting in animals which have diminutive hemispheres, or none at all.

The ciliary body may be conveniently described as consisting of an upper and an under layer. The upper layer begins as far forward as the cribriform plate above-mentioned, where it has the breadth of the anterior peduncle. As the latter becomes broader, so does the upper layer of the ciliary body, which terminates where the upper and posterior lobe meets the nucleus of the hemisphere. It appears probable, but it is very difficult to determine, that the two layers are continuous at their posterior margin, and thus enclose a cavity filled with fasciculi from the anterior peduncle: laterally the two layers are distinctly continuous. The under layer has a long and a short process, which mark the boundaries of the nidus. The long process is external, reaches downward to the inferior peduncle, and ends in the eminence already spoken of. The short process ascends transversely across the anterior peduncle to its inner margin, and opposite to the stem of the pyramid unites with the upper layer. The ciliary body has some analogy with the hippocampus; the cineritious matter in which is folded, though not indented, except at its margin, and is too [illegible] grayer colour. The corpus ciliare may be a [illegible]glion; that is to say, may belong to the same class [illegible]arts with the corpora striata and the thalami. Like [illegible]se, it has a lamina cribrosa, is very vascular, and is

Remarks upon the Spinal Chord and the Nervous System generally.

In this and the preceding number I have now published the substance of all the essays of Reil on the structure of the brain, which are contained in his Archiven für die Physiologie. I should have closely translated the original, but that the introductory remarks are uninteresting, and the descriptive parts, at the same time that they are exceedingly elaborate and minute, as well as strictly accurate, are yet wanting in precision and method, and involve frequent repetitions. As it is, I have abridged many parts. Those who may take the trouble of studying these essays will do well first to consult the adjoined engravings and accompanying references, and to endeavour to dissect hardened brains in imitation of such preparations, as the drawings represent; subsequently to which it will be found easy to verify the statements contained in the preliminary passages.

Notwithstanding the profound and successful researches of Professor Reil, much yet remains to be ascertained in order to complete a theory of the structure of the brain; and it is probable that the principal source, from which a further illustration of this important subject may be expected, consists in an extensive application of the method of Reil to com-

parative anatomy. I have not as yet given up any time to the inquiries to which I allude; but I have pursued them sufficiently to convince me of their value. I take the present occasion of mentioning a few circumstances relating to the spinal chord.

The spinal chord has a furrow before and behind in the median plane, and one again on either side of and parallel to each of these, at which the filamentous roots of the spinal nerves are attached.

When the spinal chord has been macerated in alkohol for two months and upwards, and its investing membranes have been removed, if the walls of the anterior median furrow be pressed aside, a cribriform surface is exposed, which has the appearance of being composed of transverse fibres.

If a transverse section be made of the spinal chord, an oval or semilunar portion of gray matter is seen to occupy the interior of either half, and, in the centre, apparently to unite with its fellow: one horn of either points forwards and outwards, the other backwards and outwards towards the posterior lateral furrow.

If the anterior median furrow be pressed open, a rent may be carried from the cribriform surface to either posterior lateral furrow, and the smaller portion of the three thus separated admits readily of division in the median plane. The medullary substance of the spinal chord tears in longitudinal and parallel fasciculi, which seem to be united reticularly, so that the unfolded surface has much the appearance of the interior of a turtle's small intestine. The gray substance

appears in part to be disposed in a similar way. The posterior roots of the spinal nerves appear to me to extend towards the gray substance; but I have not as yet been able to trace either these or the anterior fasciculi distinctly to that origin. In a spinal chord, which had been macerated in alkohol for two years, I found a transverse and cribriform plate extending across the middle of the spinal chord, which tore into parallel and transverse fibres.

The connection of the parts of the spinal chord with those of the medulla oblongata has appeared to me the following. If the posterior pyramid be detached from the margin of the lozenge-shaped field of the fourth ventricle, it appears prolonged as a fasciculus on either side of the posterior median furrow. If the corpus restiforme be detached from the cerebellum, and drawn downwards, it carries with it a broad lateral surface of the spinal chord, including in its centre the posterior lateral furrow. If all the superficial substance between the internal margin of the corpus restiforme and the anterior pyramid, that is to say, the corpus olivare, with its laterally adherent fasciculi, be drawn downward, the remaining surface of the spinal chord is raised, which contains the anterior lateral furrow. Finally, if the anterior pyramid be divided at the inferior margin of the annular protuberance, and drawn downwards, it is seen, at an inch from the latter substance, to dip obliquely backwards, to cross over to the opposite side, decussating the fasciculi of its fellow, and then apparently to descend in the length of the spinal

chord within the prolongation of the corpus restiforme, accompanied, it would seem, by an extension of substance from the floor of the fourth ventricle. After tearing asunder the two lateral portions of the medulla oblongata, from either rent surface a thin stratum may be raised, which is composed of parallel fibres, extending directly from the anterior to the posterior median furrow: between these fibres vessels are lodged.

To pass from the preceding details to a general consideration of the nervous system, it may be remarked:

1. That, in vertebral animals, in mollusca, in articulated animals, and in the higher zoophytes, as, to specify an individual, in the Asterias aurantiaca, the nervous system consists of two distinct parts; of a centre, which has a certain relation to the form of the animal, and of medullary chords, or nerves, derived from that centre to different organs.

2. That in the families of animals above enumerated, the nerves of sensation and motion, which supply any given region in the body, are derived from one and the same part in the nervous centre.

3. That, in connection with this anatomical law, an influence may be propagated from the sentient nerves of a part, to their correspondent nerves of motion, through the intervention of that part alone of the nervous centre, to which they are mutually attached. Thus in vertebral animals, in which alone the fact is questionable, when the spinal chord has been divided in two places, an injury of the skin of either region is

followed by a distinct muscular action of that part. Again, if the brain be quickly removed from the head of a decapitated pigeon, excepting only the fore part of the crura cerebri, together with the tubercles and the second and third nerves, on pinching the second nerve the iris contracts.

4. That each individual among the animals above specified, at one time or another, executes instinctive movements. Thus animals newly born instinctively select and convey to their alimentary cavity their proper food. Instinct is an arbitrary connection between certain internal feelings, and the will to execute particular movements which, in this case, do not proceed from imitation, habit, or the expectation of an advantage to be derived from them. The same actions, which are at one time instinctive, may, at another, spring from a different principle.

5. That the nervous centre, which, in the Asterias aurantiaca, according to Tiedeman, consists of an equal ring, with five points (corresponding with the five rays of the animal), at which nerves are given off, gradually, in the scale of improvement, becomes disproportionately developed at one part, which is, or corresponds with, the brain. In the Laplysia fasciata, M. Cuvier describes the nervous centre as consisting of five ganglions, united by medullary chords; of which one is placed upon the œsophagus, and is united to a second and a third, one on either side, by three medullary chords; and to a fourth, placed below the mouth, by two filaments. The fifth ganglion, which

is remote from the four preceding, is united by one filament to each lateral ganglion *.

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* M. Cuvier describes the superior œsophageal ganglion as the brain of the Laplysia. It would appear, from the following description, by M. Cuvier, of the distribution of the nerves in this animal, that the suboral ganglion has an equal right to be considered equivalent to a medulla oblongata. I have besides in view, in this note, the illustration of my second general position.

"Le ganglion inférieur ou suboral donne quatre nerfs de chaque côté, un pour l'œsophage et les glandes salivaires, et trois pour les muscles de la bouche.

"Le cerveau en fournit trois de chaque côté pour les parties musculaires de la tête, dont ceux du côté droit donnent des filets à la verge, et un pour le grand tentacule, qui donne une branche à l'œil.

"Chacun des ganglions latéraux en donne douze ou treize, qui se perdent tous dans les parties musculaires de la grande enveloppe du corps : je les ai représentés avec exactitude. Le petit collier, qui passe sous l'artère, en donne un impair.

"Les viscères reçoivent les leurs d'un ganglion à part, qui fait par consequent l'office de sympathique ; c'est le quatrième, ou le petit. Il donne un nerf au foie et aux intestins, un autre aux parties de la génération ; celui-ci forme encore un ganglion presque imperceptible, mais rouge comme les autres ; un troisième aux branchies ; le quatrième se perd dans les parties musculaires situées sous le couvercle."—Cuvier, Mem. des Mollusques.

6. That, in connection with this change in the form of the nervous centre, the nervous influence, which, in the Asterias, appears equally diffused, and in each region independent and sufficient for itself, is now accumulated towards the brain, or parts corresponding with it, the separation of which impairs the functions of the rest.

M. Cuvier mentions, that a separated ray of the star-fish will live by itself. M. Rolando mentions, that, on removing two of the ganglions from the œsophagus of the Laplysia, the animal quickly perishes.

7. That, in vertebral animals, the form and bulk of the cerebellum, and of the hemispheres of the cerebrum, appear to have no fixed relation to that of the spinal chord, medulla oblongata, and the adjoined tubercles.

8. That from the history of acephalous infants, which have survived their birth for a short period, it appears that movements, resembling instinctive movements, have been performed by human beings, in which the cerebellum, and the hemispheres of the cerebrum, were wanting.

It is extremely difficult to determine by experiments the precise value of parts of the nervous centre, in as much as the results, which ensue on its partial removal, may depend as well indirectly as directly upon the injury. It is well-known, that some very successful attempts have been recently made by MM. Rolando, Fleurens, Majendie, Serres, the details of which are contained in M. Majendie's Journal, to illustrate the

influence of the cerebrum and the cerebellum. If the experiments to which I allude lead as yet to no definite conclusion, for the reason assigned above, the facts which they disclose are yet full of interest.

After the removal of the upper part of the cerebellum, pigeons stagger as if intoxicated. After the entire removal of the cerebellum, they throw themselves convulsively backwards, and revolve in a vertical plane; then lie forward on their breasts, their heads bent backwards, their wings half extended, and unable to sustain themselves on their legs: they are sensible, and, when excited, move all their parts convulsively. These effects I have witnessed on repeating experiments of M. Fleurens.

M. Serres ascertained, that the destruction of one hemisphere of the cerebellum in dogs and horses produces an hemiplegia of the opposite side.

After the removal of the tubercles, pigeons and frogs move round and round in the horizontal plane. Frogs stop, and then spontaneously resume this movement. After the removal of the hemispheres of the cerebrum above the tubercles, pigeons seem stupified, but sustain themselves on their feet, and, when roused, exhibit their usual gestures for a brief space. Frogs move about as briskly, and with the same precision, as before the removal of the hemispheres. M. Rolando further mentions, that certain cold-blooded animals seem incapable of loco-motion after the removal of the cerebellum.

These facts seem indeed to show, as M. Rolando and

M. Fleurens have supposed, that the cerebellum has greatly to do with loco-motion; but it is by no means determined by them that this organ is the source of loco-motion, as the former or the regulator of loco-motion, as the latter physiologist infers. If the cranial cavity of a living pigeon be exposed, and all the parts anterior to the cerebellum be separated from the cerebellum and the medulla oblongata by a vertical incision, not made with any violence, the bird falls convulsed, and much in the same state as after the removal of the cerebellum. Again, if the cerebellum of a frog be removed, the animal moves about at first as briskly as before the injury. If then the tubercles and cerebral hemispheres be removed, leaving the medulla oblongata and crura cerebri entire, the movements of the animal continue, but it has a tendency to move round and round, and rather crawls than springs. Finally, if the medulla oblongata and crura cerebri be separated from the spinal chord, the animal lies relaxed and all but lifeless, though still for a while an injury of one of its extremities will produce motion in one or more limbs, and sometimes of its entire body.

The additional experiments immediately wanted to illustrate this subject consist in the division of the three peduncles of the cerebellum, of either pair singly, as well as in different combinations. The corpora restiformia, which are in some degree of connection with the cutaneous portions of the spinal nerves, expand in the cerebellum towards its circumference. The lateral peduncles derived from the substance of the

cerebellum are interwoven with the fasciculi of the pyramids. The superior peduncles again, on emerging from the cerebellum, ascend towards the tubercula quadrigemina and thalami, with which they are in some degree connected, as well as with the black matter, and with the origins of the fourth nerves: subsequently, either superior peduncle is inclined downward through the cylinder of the crus cerebri towards its crust, being finally brought into connection with the surface from whence the third nerve arises, and with the fasciculi derived from the pyramids and corpora olivaria, which, in their inferior continuation, are more or less associated with the remaining voluntary nerves.

THE END.

Fig. I.

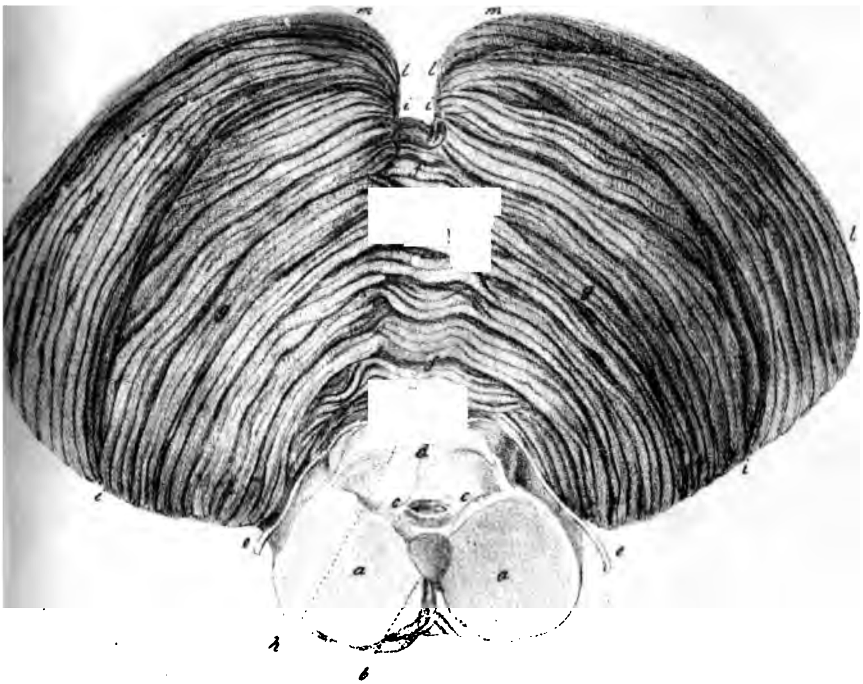
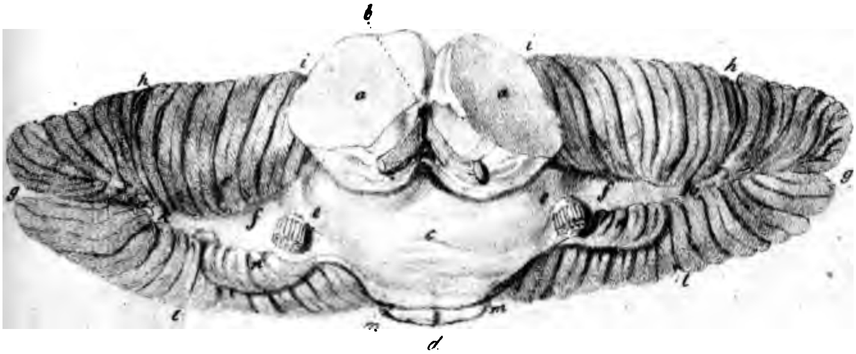


Fig. II.



Tab.I

Fig.1.

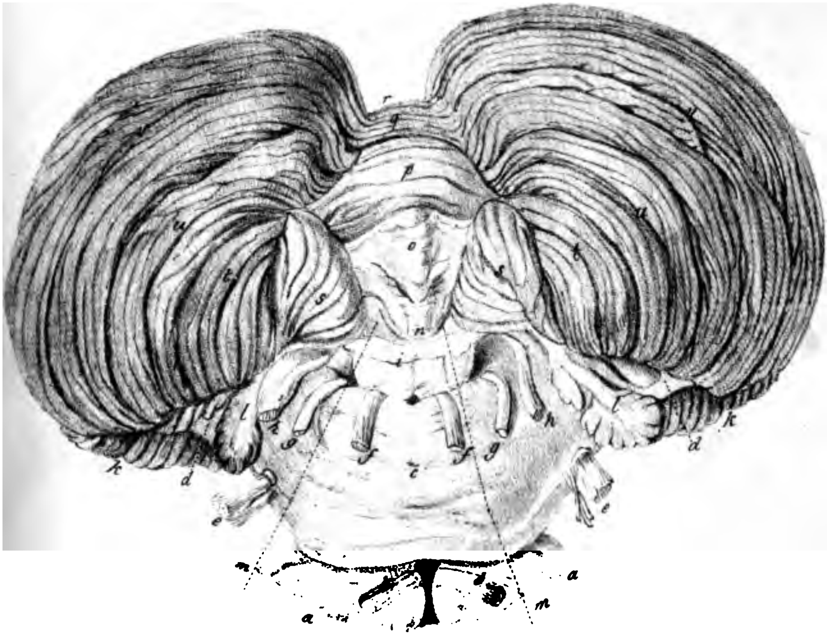
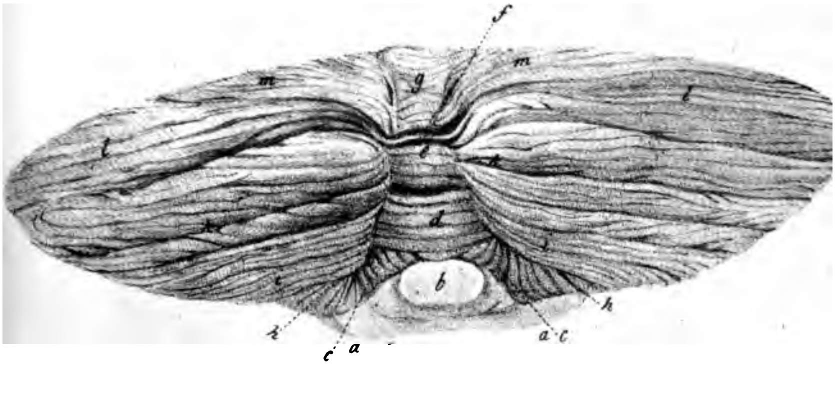


Fig.II.



Tab. III.

Fig. I.

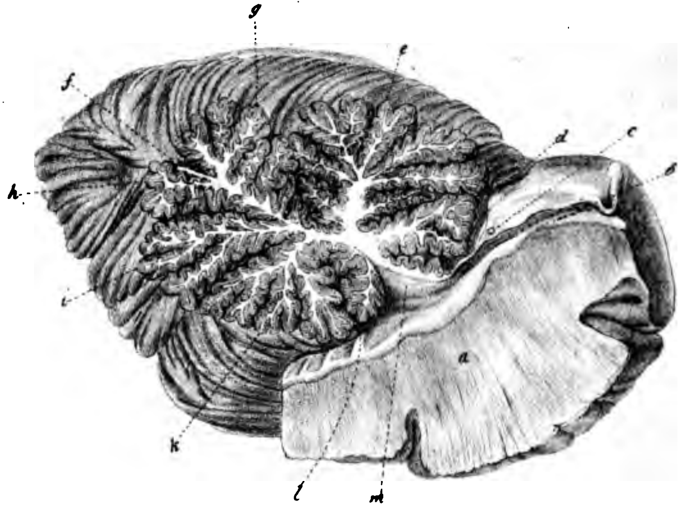


Fig. II.

Fig. III.

Tab. IV.

Fig. 1.

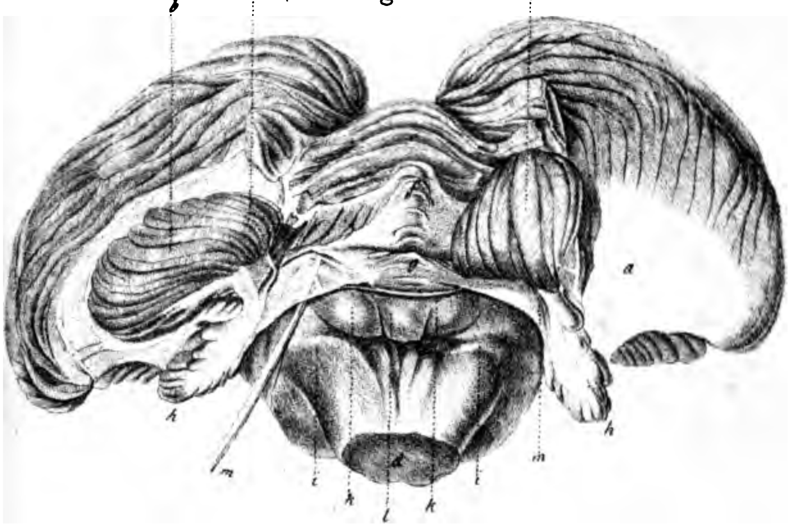


Fig. II.

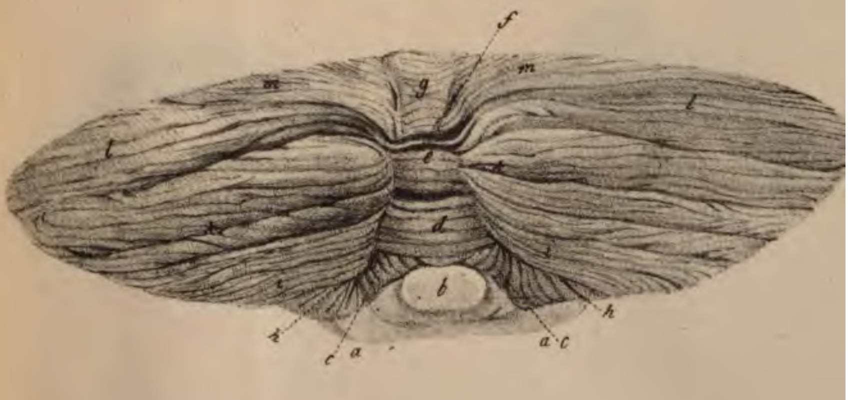
Fig. III.

Fig. IV.

Tab. I

Fig. 1.

Fig. II.



Tab. III.

Fig. 1.

Fig. II.

Fig. III.

Tab. IV.

Fig. 1.

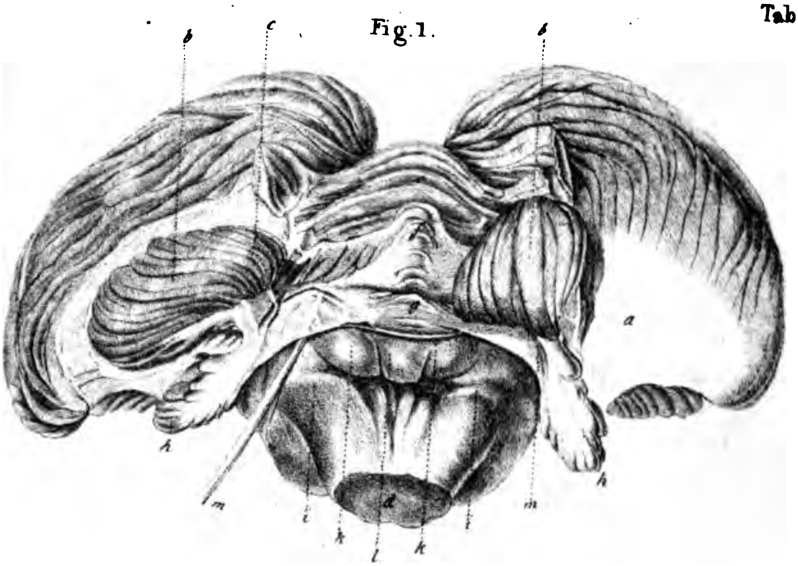


Fig. II.

Fig. III.

Fig. IV.

Ta

Fig. I.

Fig. II.


B
A

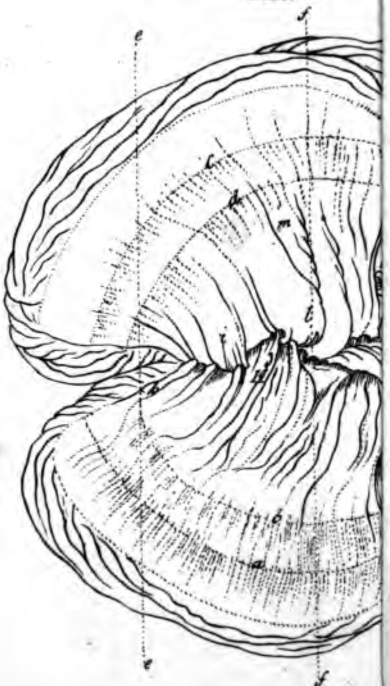

e
f
c
d
m
b
a
e
f

Fig. I.

Fig. II.

Fig. 9.

Fig. 5.

Fig. 4.

Fig. 3.

Fig. 1.

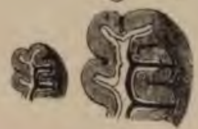


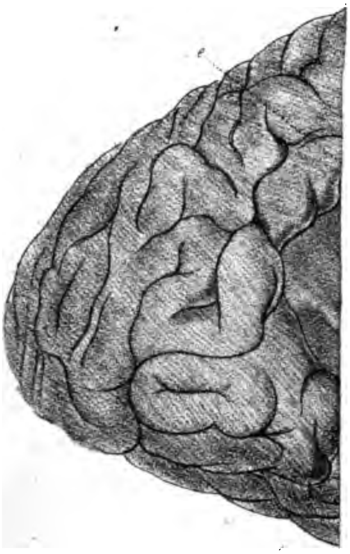
Fig. 7.

Fig. 2.

Fig. 8.

Fig. 6.


B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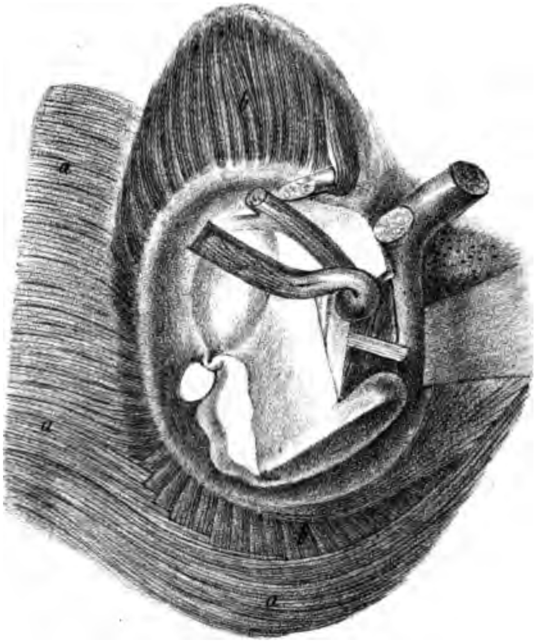
Tab.XIV.



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